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GEOGRAPHICAL REVIEW

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THE AMERICAN GEOGRAPHICAL SOCIETY
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OCTOBER
1928

OUR CONTRIBUTORS

SIR HUBERT WILKINS' first polar experience was gained with Stefansson from 1913 to 1916 on the Canadian Arctic Expedition. He left that expedition to join the Australian Air Force for the last two years of the World War, having already had flying experience as a photographic correspondent during the Balkan Wars. He was in the Antarctic from 1920 and 1921 and again from 1921 to 1922, on the latter occasion as naturalist on Shackleton's last expedition. Then followed his leadership (1923–1925) of the Wilkins Australia and Islands Expedition for the British Museum (Natural History). The three seasons' work in the Arctic (1926–1928) was preliminary to the Antarctic expedition that he is about to undertake (see July number of *Geogr. Rev.*, page 499).

SIR NAPIER SHAW was for many years director of the Meteorological Office (London), and his name is closely associated with the recent great developments in meteorology, especially in connection with the investigation of the upper air. His profound knowledge of modern physical meteorology is well illustrated in his recent publications "The Air and Its Ways" (1923) and "Manual of Meteorology" in 4 volumes (1919–). To the *Geographical Review* he contributed "World Weather: A Review" (July, 1924) and "The Earth's Evolution: A Review" (April, 1925).

DR. R. H. BROWN, assistant professor of geography at the University of Colorado, has started a monographic study of the San Luis Valley. He has published articles in the *American Journal of Science*, the *Journal of Geography*, and the *Scientific Monthly*.

MR. BENNETT is attached to the U. S. Bureau of Soils and Chemistry. The following works are indicative of the special sphere of his activities: "The Soils and Agriculture of the Southern States" (1921); "Some Geographic Aspects of Western Ecuador" and "Agriculture in Central America" in *Annals Assn. of Amer. Geogrs.*, September, 1925, and June, 1926, respectively; and, with R. V. Allison, a work on "The Soils of Cuba" (1928). To the January, 1928, *Geographical Review* he contributed the paper "Some Geographic Aspects of Cuban Soils."

THE REV. MR. BEYNON is pastor of the Centenary Methodist Church, Detroit, the membership and services of which are entirely Hungarian. He is of Irish ancestry and was an officer in the Indian Army during the World War, and his ethnological interests embrace the Celtic people and the peoples of India as well as the Hungarians. To the October, 1927, *Geographical Review* he contributed the paper "Isolated Racial Groups of Hungary."

PROFESSOR SEMENOV-TIAN-SHANSKY is a son of the distinguished Russian geographer, Peter Semenov-Tian-Shansky. He is professor of geography in the University of Leningrad and president of the Faculty of Sciences of the Russian Geographical Society, collaborator of the Academy of Sciences, and director of the Central Geographical Museum which he founded in 1919. His geographical work covers a great range. He began his career as a geologist and has carried out regional geomorphological studies. He acted as secretary of the Main Committee of the First General Census of Russia of 1897. Altogether he has written, initiated, or edited about 150 scientific works, among which may be mentioned a "Complete Geographical Description of Russia" of which 11 volumes appeared between 1899 and 1914; "Commerce and Industry of European Russia for 1065 Economic Regions," in 13 parts, with wall map, 1900–1911; "Region and Country" (1928)—the first part of a large work on the bases of knowledge of the country.

DR. SPINDEN is curator of Mexican archeology and ethnology in the Peabody Museum, Cambridge, Mass. He has specialized in the study of the ancient civilizations of Mexico and Central America and has carried out extensive field work in these regions. His numerous writings include an important monograph, "The Reduction of Mayan Dates" (1924).

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Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.

THE
GEOGRAPHICAL REVIEW

VOL. XVIII OCTOBER, 1928 NO. 4

THE FLIGHT FROM ALASKA TO SPITSBERGEN, 1928, AND THE PRELIMINARY FLIGHTS OF 1926 AND 1927

Captain Sir Hubert Wilkins

WHEN the Detroit Arctic Expedition of 1926 was first planned there were two large areas, one in the Arctic and one in the Antarctic, still to be explored.[1] The main object of the Detroit Arctic Expedition was exploration in the unknown Arctic. There were other things of interest on which it was also hoped to shed light, more particularly on meteorological conditions in the area and the possibility of the establishment of meteorological stations there; and on aerial transportation in the Arctic.

Through a study of universal meteorological conditions we can hope to provide information of extreme value to primary producers and so help to feed the ever increasing population of the world, and we can at the same time and from the same source aid travelers who in the near future will be taking advantage of the whole world's surface—of latitudes far above the polar circles and of altitudes far above the mountains and the seas. From the beginning of history mankind has been concerned with and greatly influenced by the weather; but it is only now, since the development of modern science has brought about long distance communication by means of wireless and speedy transportation by means of aircraft, that we can expect to carry out and make use of observations which might give us some information as to the mechanism of the weather. If a knowledge of the weather system can be gained, then we can on long distance flights by aircraft expect to take full advantage of natural conditions instead of being, as we are now, at their mercy.

[1] A brief statement of the expeditions and their objective is given in "Captain Wilkins' Arctic Expeditions, 1926–1928," *Geogr. Rev.*, Vol. 18, 1928, pp. 489–494. The detailed reports of the expeditions and the original field records are deposited with the American Geographical Society.

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Suitability of Airplanes for Arctic Transportation[2]

The question of suitable landing fields in the Arctic is of the first importance. Airplanes even now are ill prepared for taking off the ground and for coming to rest. In most instances fields must be prepared before they are fit for landing places. But along the lagoon-fringed shore of the Alaskan Arctic coast there are hundreds of miles of ice as flat as a table. Throughout much of the year this ice is covered with snow not more than ten or twelve inches deep. I had gained considerable experience with aircraft during the years 1910–1913, and when I was with Stefansson in the Arctic during 1913–1916 I was able to look at the ice surfaces from a pilot's point of view; day after day as I traveled along the Arctic shores and over the sea ice, my attention was drawn to many suitable landing fields. In summing up the conditions it was my estimate that near the Alaskan shore in late winter and early spring, both near the land and on the sea ice, emergency landing fields could be found within a radius of twenty miles from any point. I believed that more suitable emergency fields would be found on the Arctic pack ice at the right season than in most unsettled country districts.

Many engineers doubted that engines would function in the low temperatures experienced in high latitudes. From personal experience with internal combustion engines used on the Stefansson expedition, I knew that gasoline motors would not function if exposed to such temperatures as would be encountered during an Arctic winter or spring. But it required little inventiveness to arrange a safe convenience for heating the air before it entered the carburetor, and it would be an easy matter by means of suitable cowling to insulate an airplane engine from the cold. The question as to whether the wings and the fuselage of the plane would withstand polar conditions had been settled by the evidence collected during Sir Douglas Mawson's expedition to the Antarctic in 1912 when he used an airplane fuselage in temperature well below zero.

The apparent difficulties with regard to equipment for polar flying seemed to me to be solved. It was only a question of adaptation by human hand. Some of us have been privileged to experience polar conditions, and we know how really comfortable they can be; but this knowledge was gained only by experiencing in our early ignorance real hardships and by learning gradually the ways of comfort. We knew from our own experience that the job of flying the Arctic could be done. We might not do it successfully, because any man and any machine is prone to fail; but that would not alter the fact that some day some one would prove to the satisfaction of the world that polar flying is not an impossibility.

[2] See also the author's contribution "Polar Exploration by Airplane" in Problems of Polar Research, *Amer. Geogr. Soc. Special Publ. No. 7*, New York, 1928.

FIG. 1

FIG. 2

FIG. 3

FIG. 1—Taking off the Fairbanks runway on the first trip to Point Barrow.
FIG. 2—The Koyukuk River (see Fig. 4). In the distance it joins the Yukon.
FIG. 3—Looking over the Endicott Mountains to the low flat tundra that extends to the Arctic Sea.

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The Flights of 1926

In order to investigate the unexplored area northward of Barrow, Alaska, we planned to take our airplanes—a three-engined and a single-engined Fokker—to Fairbanks, the most northerly point in Alaska to be reached by ordinary means of transportation, and then fly with our supplies to Point Barrow, the most northwesterly point of the American continent and within fifty miles of the unexplored area. From Barrow we proposed to make several flights over the Arctic Sea and, if our experience should make it seem possible and safe, to undertake a flight from Barrow to Spitsbergen.

Trial flights at Fairbanks resulted in accidents to both planes. The single-engined plane, however, was ready three weeks later; and on March 31 with Eielson as pilot the writer as navigator flew from Fairbanks toward Barrow, following a compass course. We crossed the north end of the Sawtooth range and passed over the Yukon Valley which was covered by fog. We approached the Endicott Mountains—which here had not been surveyed at all—at an altitude of 6000 feet. The range was bathed in sunshine, and we saw that the mountain peaks were higher than we were. We climbed to 9000 feet with difficulty. That seemed to be as high as the loaded plane would go, but the mountain peaks were still higher. We threaded our way through them.

North of the mountains the land was covered with cloud 4000 feet thick. Conditions were confusing because a high following wind had brought us to the Arctic slopes in much less time than we had anticipated. My observations for ground speed and drift gave some indication of our great speed. We continued our compass course above the fog for 200 miles and then saw beneath us ice, of whose character from an altitude of 5000 feet I was not certain. It might have been lagoon or lake ice or the ice of the Arctic Sea. We flew on, keeping the same compass course. In a few minutes we were in clear atmosphere and over unmistakable Arctic Sea ice. Undoubtedly we had passed Point Barrow. Finding ourselves in this position we decided to go still farther north and do some useful exploration before returning to Barrow. We continued on in clear conditions for 150 miles, then reversed our course and flew back to the edge of the clouded area. We flew southeast for 50 miles, to be certain we were over land, then coming down as low as possible, flew due west to the cliff formation which we knew fringed the coast southwest of Point Barrow. We sighted the "cut bank" and then swung sharply to follow it, in less than twenty minutes reaching the village of Barrow, which could not be seen that day from more than a mile distant.

We landed on the Barrow lagoon in a wind of about 40 miles an hour, in a temperature of 30° below zero Fahrenheit. It had been colder earlier in the day. The wheels of the machine hardly marked the

snow. The surface of the lagoon that day was as good and hard as any turfed landing field. A storm held us at Barrow for five days, during which time much soft snow fell, blanketing the surface. By the time we could leave, the soft snow on top had so warmed the hard lagoon surface that the wheels cut through to the solid ice. However,

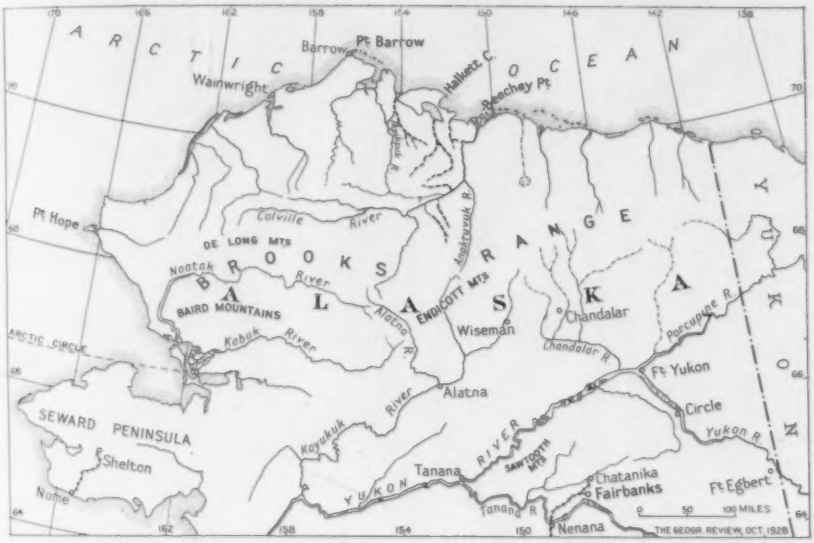

FIG. 4—Map of northern Alaska, scale 1:12,000,000. The courses of rivers shown by heavy dashed lines were sketched by Captain Wilkins from the air.

after several attempts we took the air and headed for Fairbanks. We maintained our course until within a hundred miles of our destination. The sky was overcast; and, failing to recognize the country, we decided to return to the Yukon River, to locate some unmistakable point. The first such position was Circle City, where the river surface near by offered an excellent landing field. To avoid any shortage of gasoline and oil on the way we descended and replenished our tanks, returning to our base the next day.

Two days later we made a second trip to Barrow. Cloud conditions were almost the same as before. The hundred-miles-wide Yukon Valley was blanketed with fog; the sky was clear over the mountains, and clouds 4000 feet high extended over the plains to the edge of the Arctic pack ice. The immediate vicinity of Barrow village was clear. After a few hours rest we left Point Barrow on the return trip. Just before we started my mitten caught in the spokes of the wheel, and my arm was drawn between the wheel and the stanchion of the landing gear. The small bone of my right arm was broken near the wrist in two places. Because of this it was advisable, in case of engine trouble, that we follow a course offering the maximum of good land-

ing grounds and facilities of travel to habitations. I shaped our course slightly to the west of a direct route to Fairbanks to strike the Tanana River that we might follow it to our base. Bad weather kept us at Fairbanks for a few days, and then we made a third trip to Barrow.

By this time spring was well advanced. The landing field at

FIG. 5—Looking eastward along the Endicott Mountains from above the Anuktuvuk River.

Fairbanks was a puddle. Rain and sleet fell at frequent intervals upon the foothills. The Endicott Mountains were, for the greater part of the day, cloud-covered. As we approached them we could see that the clouds were too high to pass over. They drooped over the mountain tops to within 2000 feet of sea level. We circled several times in an endeavor to get through, only to meet thick clouds or monster peaks. It was as easy to fly in one direction as another; and so we decided to stick to our course, climbing as much as possible. The machine with the heavy load, however, could not climb high enough to clear the mountain peaks. I believed that if the load were piled toward the nose of the machine it might help us, and so I carried the cases of gasoline to the forward part. I then had time to look out of the window and at that moment saw a steep high peak just ahead. I shouted to Eielson to keep to the left, but he was avoiding a peak on his side. There was barely room for the wings to pass between them, and it looked as if we were not high enough to clear the snow. I was watching the wing tip and was too anxious perhaps to notice a slight shock, but on looking down I saw the wheel of the machine spinning as fast as if we had just left the ground. Fortunately the valley we entered in such a manner led to the Arctic plains below. Cloud conditions over the tundra were similar to those of our first experience: we rarely caught a glimpse of the ground beneath us.

Unsettled weather continued. We made two attempts to return to Fairbanks, on both of which we were forced back. Once, because a storm had developed at Barrow in our absence, we had great difficulty in reaching the village. It was necessary to fly out far over the Arctic Sea and then come down to within a hundred feet of the rough

FIG. 6—The view northward from the head of Wild Creek, a headwaters stream of the Koyukuk.

sea ice and check our course by the direction of the snowdrifts until we reached the coast and then, with only a few feet of altitude, follow the coast to the village. An accident to the propeller delayed us further. It was temporarily repaired, and finally we succeeded in getting off and reached Fairbanks without incident. The damage done to the propellor prohibited use of the smaller plane again, and thus we had only one hope left—the three-engined machine, which the two expert army pilots, Major Lanphier and Sergeant Wisely, declared unserviceable. I decided to give them the opportunity to revise their reports.

The season was late, too late in fact for us to be sure that we could do anything of value. The snow had cleared from the Yukon Valley, and the rains had melted most of the snow from the mountains. Thick clouds hung over the Endicott peaks. We left Fairbanks with a load of over 7000 pounds in the machine. We steadily climbed to 11,000 feet and after a battle of two hours flew over the clouded top of the range. We had then to face a two-hundred-mile flight on a compass course. It was an ordinary thing to me because we had done so on each previous trip. But neither Major Lanphier nor Sergeant Wisely had made the trip before. The grayness on the horizon gave no more vision than if we had been enveloped in a mask of gray silk. It looked ominous to them. Suddenly we dived from 11,000 feet

until we nearly reached the ground. The machine seemed to be out of control, but the pilot flattened it out. He had decided to try to fly beneath the clouds a few feet above the snow instead of over them. But the fog was too thick. From a height of 500 feet we could see a few black objects on the surface, but we could not have kept direction; and so it was necessary to turn back, fly out of the cloud, and climb again above it. We again set a compass course for Barrow and as expected, after flying some two hundred miles, came to a safe landing on the lagoon and taxied to a suitable place for another start. But spring conditions had already set in at Barrow. The fog which had hitherto cloaked only the tundra was creeping out over the Arctic Sea ice, making it unlikely that we could serve any useful purpose by flying northward.

Hoping that we might at least have one clear day, we waited for a period of two weeks; but the fog did not lift. With great difficulty we rose from the lagoon and flew back through the clouds and bad weather to Fairbanks.

The Flights of 1927

While in 1926 we had done a great deal to confirm our confidence in the possibility of successful Arctic flying and had gained considerable experience, we had explored very little of the Arctic Sea ice. The Amundsen-Ellsworth-Nobile flight in the dirigible north from Spitsbergen to Alaska was popularly believed to have eliminated the possibility of discovering land between Barrow and the pole; but, while these men skillfully flew for a great distance over cloud and reached their destination, the conditions beneath the clouds could not everywhere be observed. Perhaps there was land, perhaps not. But even supposing the trip of the *Norge* had cleared the area north of Point Barrow, there were still great areas to the northwest and northeast to be explored. To investigate these areas was my original plan. It was to include at least two flights of about 600 miles from Barrow to the northwest and northeast and, if land was not found, a descent onto the ice to take soundings. When that work was done the advisability of making a nonstop flight to Spitsbergen would be considered.

It was intended that the entire personnel of the expedition should go to Barrow at the same time with the three planes—two Stinsons and the reconditioned Fokker. Everything was prepared, but the night before the attempt soft snow fell and covered the runway. The Fokker failed to leave the ground and in taxiing back for a second try ran into a snow-filled gutter and broke one of the skis. I decided to leave it at Fairbanks until we had completed the short flights into the Arctic. The two Stinson machines made nonstop flights to the Arctic coast. One machine was made ready for a flight over the Arctic Sea four days after our arrival. With Eielson as pilot and

FIG. 7

FIG. 8

FIG. 9

FIG. 7—The *Alaskan* at Point Barrow, 1926.
FIG. 8—The machine was parked on the smooth lagoon ice, its engine housed in a windproof tent.
FIG. 9—The Lockheed Vega monoplane used on the flight from Barrow to Spitsbergen being hauled from the trading post at Barrow to the starting point.

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myself as navigator, we set out on March 29 on a northwestward course, hoping to reach latitude 80°, longitude 180°. We planned to travel out six hours, land, take soundings, fly south for two or three hours, and then return to Barrow. We hoped to take advantage of meteorological conditions which would give us a favorable wind for the first four or five hours; calm conditions for the flight to the south; and, on the calculated movement of storm and wind, a following wind for the last four hours on our return.

The temperature was 42° below zero Fahrenheit at 6 a. m. when we started; a light wind blew from the east-southeast, which we expected would increase and swing to the southwest before we returned. As we proceeded on our course the temperature rose; the wind changed also, giving us additional speed, but did not change as rapidly as expected. Near Barrow there was much broken ice and many newly opened leads. This fact warned us that the storm was of greater proportions than I at first anticipated, but having started I was loath to turn back. We crossed ordinary pack ice most of the way. Four hundred miles out we came to old heavy pack, traveled over it for a hundred miles, and then came to ordinary pack again. Ahead we saw indications which led us to believe that we must be coming to shallow water: many open leads and pressure ridges could be seen in the distance. After five hours the engines started missing badly; ten minutes later we were forced to land. I immediately set about taking a sounding; Eielson looked for the engine trouble.

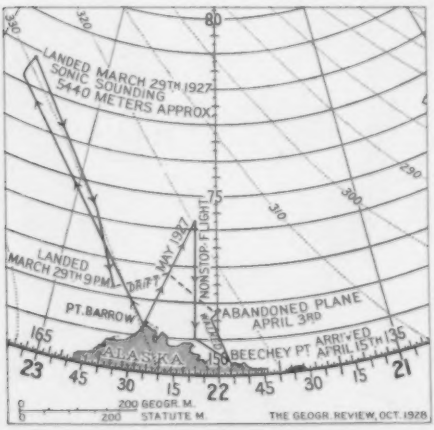


FIG. 10—The flights of 1927. On that of March 29, only two sets of astronomical observations were taken during the actual flight, the first three-quarters of an hour before the first landing and the second about an hour and a half after starting again. The actual position of the first landing given as 77° 45′ N., 175° W. is therefore principally dependent on the accuracy of the dead reckoning, though not entirely. After the second landing the drift of the ice was checked four times by double sets of observation on the sun.

We had landed on a section of comparatively young ice, about 700 yards long and 500 wide, between old floes. The ice beneath us was about three feet thick with very little snow on its surface. Two holes were punched through the ice, and echo soundings gave us a depth subsequently worked out as 5440 meters.[3] The estimate of our position was latitude 77° 45′ N., longitude 175° W. There seemed little possibility of finding land near by. It took half an hour to get the

[3] *Geogr. Rev.*, Vol. 18, 1928, pp. 491–492.

soundings and another half hour to get the engine going, and even then it worked only moderately well. After three attempts we managed to get into the air, but after a flight of ten minutes we were again forced to land. We then worked for two hours on the engine with fairly good results. It was by that time too late to attempt a flight to the southward; and, as we had expended a considerable amount of our gasoline, we decided to return direct to Barrow. While we were working on the engine the storm increased to alarming proportions: instead of being able to fly back with the wind we found that there would be a strong wind against us. We should undoubtedly drift to the west if we remained on the ice, and so I thought it advisable to attempt to return to Barrow at once.

For seven and a half hours we flew over a course which we had covered in less than five and a half hours on our outward journey and then, when our supply of gasoline gave out, descended through the hazy dusk to the ice. It was impossible for us to see beyond the windows of the machine, yet we came safely to rest on a smooth piece of ice with only slight damage to the skis on our machine. The bad weather prevented us from fixing our position until the next morning. Then we learned from two indifferent sun observations and an estimate of the drift of the ice that we had landed about seventy-five miles to the northwest of Barrow. The stormy weather was such that it was advisable for us to remain with the machine for five days, during which time we improvised sleds from the tail skid of the machine; and on the sixth day from a position some two hundred miles to the east of where we had landed we set out on foot headed for Beechey Point on the Alaskan shore, about eighty miles distant in a straight line.

We were equipped with spare clothing, sleeping bags, a Primus stove, and sufficient food to last us at least thirty days. The food consisted of a few ounces of pemmican but mostly of biscuits and sweet chocolate. We built for ourselves snow houses each night, and after two or three nights and in order to reduce weight we abandoned all but one half of a sleeping bag, in which we both put our feet at night. Our fuel when we left the machine was less than half a gallon; consequently we decided to eat our food cold and drink only cold water. We did not care to ration ourselves but found when we reached shore that we had consumed less than fifteen ounces of dry food each day. Even with this small amount we did not feel exhausted or hungry; and, although our packs, which we early substituted for the improvised sleds, weighed more than eighty pounds apiece we walked on an average more than ten hours a day and spent perhaps three or four hours more in preparation for camping and breaking camp. The reason why so much time was taken in making and breaking camp was because Eielson had so badly frozen his fingers that it was impossible

for him to cut snow blocks for the house or to look after his own boots and clothing; hence this work fell to me and took up considerable time.

Much of the pack ice over which we crossed was so badly broken and so covered with soft snow that we found it impossible to walk, and the best means of progress was on hands and knees. It took us thirteen days of hard traveling. As we were nearing the coast we could see Beechey Point trading house a little to our left. Our navigation had been practically correct. We soon reached the trading station and in a week were again at Point Barrow.

Eielson had one finger so badly frozen that the two lower joints had to be amputated. This made it impossible for him to go out again on the ice that season; consequently with Alger Graham as pilot I set out with the second machine on a flight northeast toward Grant Land, expecting to reach Etah or the Royal North West Mounted Police Station on Bache Peninsula, opposite Etah. But the season was so far advanced that heavy fogs covered the Arctic Sea ice; and, although we flew for 250 miles out over the Arctic Sea, we never once, after the first 20 miles, saw any signs of the surface. To have continued would have served no useful purpose; and hence we returned to Barrow and, after waiting vainly for the weather to clear, went back on the fifth of June to Fairbanks, our efforts postponed until the season of 1928.

The Flights of 1928

As before, we left Seattle the second week in February. At Seward we experienced a delay of a week because of the unusual weather conditions. A thaw had set in, and the railway line to Fairbanks was blocked by heavy snow slides. We flew from Fairbanks to Barrow on March 19 and there set about the final preparations.

In 1927 I had planned to take advantage of the storm conditions that usually occur at Barrow some time between the last week in March and the first week in April; but in 1928 I decided to wait until after that storm period was over and take advantage of the fine weather which, judging from our own experience and the record kept at Barrow for the last twenty years, usually follows the storm. We expected to wait until a light northeasterly wind and other indications pointed to an anticyclone developing off Point Barrow, because I believed that the flying against this light wind for the first five hundred miles would be more than compensated for by the following wind which we should probably have at the end of our journey, providing of course that we did not find land. If we did find land, we proposed to come down and wait until we had the prospect of fine weather again at Barrow.

It was not until after three vain attempts that we were able to get in the air with the load we carried. We left the Elson lagoon just

north of Barrow village at 10.15 a. m. on April 15. Once in the air we headed directly out over the ice on our course toward Spitsbergen (see Fig. 18).

Shore Conditions of Northwestern Alaska

The coast for many miles southwest of Point Barrow is bordered by tundra-covered banks ranging from five to thirty feet high. To the east of Point Barrow a long line of sand spits and islands shelter the mainland coast. Between the islands and the coast on the sea and lagoons during winter the ice surface is smooth and flat.

Fig. 11—Captain Wilkins about to start on the 1928 flight.

The ice near the coast at Point Barrow is generally broken and scattered between the first of July and the middle of August. A few miles offshore from Point Barrow the ice, even in winter time, is generally in motion: wide leads open and shut from time to time. Through the year there is generally to be found an open lead, boomerang-shaped, around Point Barrow and about three to ten miles out from shore.

At the shore-side edge of this lead there is usually a very large and wide pressure ridge. The greatest height measured at any one point on the ice ridge we saw was not more than forty feet, more usually the ridge was about six to eighteen feet high. The width varies but may average half a mile. While the same general conditions are found near the coast, they vary considerably; in no two years are they alike.

Details of Ice Crossed When Following Course

After crossing the smooth lagoon ice of our starting point we came to inshore pack ice fringed at the edge of the open water by a high pressure ridge. Beyond this to latitude 72°—a distance of about fifty

miles—the ice was much scattered and broken, a great deal of clear water being exposed. This was due in my opinion to the fact that strong northeasterly winds experienced the few days before had broken up the ice which now was drifting with the ocean current.

The movement of the ice, I might mention here, is sometimes an indication of the direction of the wind to come. It seems that the influence of the wind on the ice travels through the ice much quicker than the disturbance travels in the air.

From latitude 72° to 73° we crossed high rough pack ice with a few narrow leads of open water running east and west on our course but turning to the north to our left. From latitude 73° to 75° there was old rough ice in which there were no open leads of water.

Newly frozen leads were observed, also other places showing where leads had been. It happened that on the day we passed they all were closed. Twenty-four hours later there might have been numerous leads. The snowdrifts on this ice were running east and west (all compass bearings quoted are true, not magnetic).

Between latitudes 75° and 77° we crossed much young ice lately frozen. This offered many perfect landing fields. Little snow had fallen since the leads had formed, and there were many square miles of flat ice without obstructions. Occasional good emergency landing fields had been observed throughout the journey, except in the much broken area near Point Barrow. Between latitudes 77° and 78° there was heavy old ice on what were high pressure ridges and high snowdrifts. At that point the direction of the snowdrifts changed suddenly from east and west to northwest and southeast.

From latitude 78° to 80° we were over a clouded area. For a hundred miles we flew over a flat-topped cloud that hid surface conditions. On the northern side of this area we saw some very old rounded ice. It was crystal clear on the surface and had probably not moved far from that spot. There were a few narrow fissures in this ice, but no wide leads or open water were seen. The snowdrifts ran east and west. In this area a meteorological station might be placed with safety on the Arctic ice.

From 82° to 83° we saw moderately rough ice with a few lanes of water at intervals. The snowdrifts in that region lay in a northeast-southwest direction. Then to latitude 84° there was light pack ice much broken and pressed, with considerable open water between. There were no great leads to be seen.

At this point we turned south and traveled over the clouds to Grant Land. From latitude 84° due east towards Greenland we followed wide leads running east and west; many pressure ridges were seen in this area, the pressure apparently coming from all sides.

Near Greenland the ice was very irregularly ridged with confused snowdrifts. Between longitudes 30° and 0° there were many

narrow leads running east and west, young ice with low ridges, and snowdrifts running north and south. On the course between longitude 0° and Spitsbergen there were light billowy clouds, almost completely covering scattered ice and open water.

The Winds and Meteorological Conditions

The average size of storm areas I had observed about Barrow was of a radius of 500 miles. My contention was that if we left Point

Fig. 12—Snowshoes for shovels. Digging out before the take-off for the flight from Green Harbor to the sealing ship which brought the machine to Norway.

Barrow at a time when a storm was about to develop, we could fly into a head wind which would gradually get lighter changing perhaps from northeast to perhaps southeast and south and that at a point about five hundred miles out on the ice we should meet a calm. In this case it was likely there would be, on the other side of the calm belt and in the neighborhood of Grant Land, a depression; by entering the edge of this depression we might have at first light, then stronger, winds to help us on the way to Grant Land and Greenland. At Point Barrow it was impossible to hazard a guess even as to the conditions we should meet at Spitsbergen. However, it was my opinion that, roughly speaking, the Arctic at that season of the year would be surrounded by a series of depressions of limited radius and that, if such should prove to be the case, we might expect after flying in a cross wind above Greenland and Grant Land to get into another disturbance as we approached Spitsbergen. If there was a disturbance in that neighborhood I believed it would center somewhere to the

south of Spitsbergen, about where the solid pack ice meets the warm drift from the Gulf Stream; its greatest influence would not be met north of the islands: therefore we should not experience head winds. I believed that the temperatures experienced north of Greenland would give me some idea of the intensity of the storm or depression.

These deductions were written down on April 22. On May 21, through the kindness of Mr. Otto Krogness, Director of the Geophysical Institute at Tromsö, I received copies of the meteorological charts covering the time of the flight. These charts are reproduced on pages 558 and 559. At the request of the American Geographical Society Sir Napier Shaw kindly undertook to prepare a brief discussion of the weather situation on the basis of the charts and the writer's observations.[4] This he has done in the succeeding article.

When we left Barrow the wind was from the east (all directions true, not magnetic) with a force of about ten miles an hour and was from the same direction when I took an observation some fifty miles from shore. Then for some time I was busy with other things, and when the next observation was taken the wind was from the north but very light, needing a correction for drift of only two degrees. We had risen from about five hundred feet altitude to three thousand feet. When we reduced altitude to about a thousand feet the wind was again from the east and gradually changed toward the south. When we were about four hundred miles out from Barrow I could see long stratus clouds forming behind us and a few dim cumulus clouds in the direction of Barrow where the sky had been clear when we left. Ahead we could see low clouds coming right down to the ice but not reaching a great altitude.

We climbed again to three thousand feet, climbing slowly and only reaching that altitude as the ragged edge of the clouds was met. For a few miles we could see through to the ice; then the cloud mass became more solid and flat-topped. The wind had been from the south when I took my last observation, but so far as I could ascertain as we flew over the clouds there was not any drift. It is impossible to say definitely whether this was so, because we were scarcely above the tops of the clouds and the only means I had of gauging our absolute direction was by taking a line on some slightly conspicuous cloud mass almost directly ahead while Eielson flew a straight compass course.

We passed over the thick cloud in about an hour, and my first observation when the ice was seen showed very little drift; but soon I noticed a slight wind from the northwest, which turned more westerly and increased in velocity as we approached Grant Land.

[4] Since this article was set up the *Annalen der Hydrographie und Maritimen Meteorologie* for June, 1928, has been received containing a discussion by M. Rodenwald, "Die Wetterlage im nördlichen Polargebiet während des Polfluges von Hauptmann Wilkins am 16 April 1928," accompanied by a weather chart for the Arctic regions for 14 H. M. E. T. on April 16.

FIG. 13

FIG. 14

FIG. 13—Mountains between Green Harbor and Advent Bay, western Spitsbergen seen from the air.
FIG. 14—Green Harbor. In addition to the government radio station Green Harbor is the site of a Dutch coal-mining concession.

In the neighborhood of Grant Land we could see to the right of our course high cumulus clouds in motion, very irregular, with the tops blown over by the wind. These were unmistakably clouds over land, and this assured me that we were not far from our plotted course. I could see a clear way round the clouds to the northward; but, in order to be absolutely sure by actually sighting land, I decided to keep on the course and turn south when we came near to Grant Land. After about twelve and a half hours out, just when we expected to be able to see the coast, it became necessary to turn from our course to the south to go round a high cloud mass. But the cloud continued too far in a southwesterly direction, and so we turned back to the east through the cloud for a few minutes. It was difficult flying, and I was just writing a note to say that we were near enough to Grant Land to be certain of it and to fly northward and go round the storm when Eielson shouted that he could actually see the land. We immediately swung north and for about thirty minutes saw intermittently a few patches of the Grant Land mountains.

As we swung clear of the cloud we encountered a wind from the north but soon passed through it into a calm area. The temperature in the cabin dropped noticeably to about zero. The thermometer outside read 48 below zero. The strait between Grant Land and Greenland was clear at its northern end, but over Greenland and beyond to the southeast we could see high towering cloud masses. Long stratus clouds streamed in the direction of the center of the disturbance, and low clouds hid the mountains of Greenland. I directed the course to the north of our track, telling Eielson to steer round the clouds. This he did. After two hours I could see one lone peak of Greenland showing up through the clouds, and for half an hour we kept this in sight. About the time we lost sight of it I could see ahead the cloud hanging over Spitsbergen. The compass or observation for drift was no longer necessary. We could steer our course by the shape of the clouds. We were in a wind from the northwest, and as we went toward Spitsbergen our ground speed increased.

About two hundred miles from Spitsbergen we encountered high cumulus clouds. We were not above them at 8000 feet but flew through cloud lanes and sometimes through the clouds themselves. Over the surface of the sea and sea ice the cloud tops were more or less level, but in the distance I could see much irregularity and believed that this condition was over Spitsbergen. It was then impossible to get the drift, but apparently we were in a high northwesterly wind. We headed toward the towering clouds, which appeared to be over the land; but on reaching these it was impossible to see through. To the east the clouds looked lower and flat; to the south they rose higher and promised to be more broken; and so we turned south, flying along what I believed to be the land cloud edge. In about fifty minutes and

just 20 hours after we had left Point Barrow we saw two small mountain peaks penetrating the cloud tops. We took advantage of this opportunity to come down to within a few feet of the sea. The clouds were thick and extended practically down to the water. Beneath them the wind force was terrific. It was almost impossible to fly along the edge of the land and equally impossible to see the land when we kept out to sea. Fortunately, we had crossed a smooth patch of snow soon after coming down through the clouds; and I directed Eielsen back to it. Although it was difficult to find and difficult to land on, we came down safely. The wind on the ground was blowing from slightly west of north, with a velocity of forty or fifty miles an hour, and drifting the snow so much that we could see only a few yards.

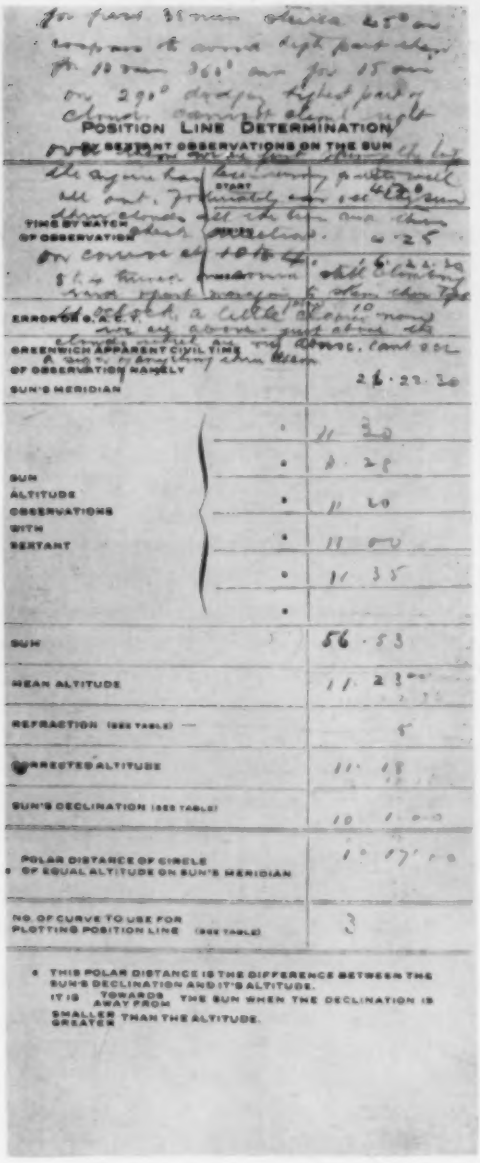
For five days the storm continued. The wind blew in general first from the north-northeast and then from the southeast, but no accurate observations were taken during that period. Our landing point we subsequently found to be Dödmandsören, so-called Dead Man's Island, the northwestern extremity of Ice Fiord.

A summary of the wind direction is as follows: for the first fifty miles on our course there was a light wind from the east; for the next two hundred and fifty miles, a very light wind from the northeast; for the next two hundred and fifty miles, the wind swung gradually through northeast to east and due south increasing in velocity. For the next two hundred miles we were either over a calm or over cloud where no observations could be taken. From the calm area we got into a light northwesterly wind, which swung more westerly and increased in strength until we came to Grant Land. From Grant Land we swung northward and out of the wind into a calm, clear, cold belt but entered a northwesterly wind again as we went beyond Greenland and approached Spitsbergen.

In general we could determine the weather ahead for at least two hundred miles. From Grant Land we could see the storm over Greenland some miles more distant. From north of Greenland we could see that a storm of great area and intensity would be met in the vicinity of Spitsbergen. The difference between cloud masses over the sea and the actual land was discernible.

Navigation

Because of the difficulties expected with compass declination and dip it was thought that no type of compass would be of much use to the navigator; and, while we had proved that the English aperiodic compass was by far the most serviceable in Arctic conditions, I had found that an ordinary ship's lifeboat compass behaved very well in our plane during flights in 1927. However, the deciding factor was that we could not afford to buy anything that was not essential;


POSITION LINE DETERMINATION

BY SEXTANT OBSERVATIONS ON THE SUN

TIME BY WATCH OF OBSERVATION

ERROR OF W.A.T.

GREENWICH APPARENT CIVIL TIME OF OBSERVATION NAMELY

SUN'S MERIDIAN 26 · 22 · 30

SUN ALTITUDE OBSERVATIONS WITH SEXTANT

SUN

MEAN ALTITUDE

REFRACTION (1932 TABLE) —

CORRECTED ALTITUDE

SUN'S DECLINATION (1932 TABLE)

POLAR DISTANCE OF CIRCLE OF EQUAL ALTITUDE ON SUN'S MERIDIAN

NO. OF CURVE TO USE FOR PLOTTING POSITION LINE (1932 TABLE) 3

* THIS POLAR DISTANCE IS THE DIFFERENCE BETWEEN THE SUN'S DECLINATION AND IT'S ALTITUDE.
IT IS TOWARDS / AWAY FROM THE SUN WHEN THE DECLINATION IS SMALLER / GREATER THAN THE ALTITUDE.

FIG. 15—Facsimile on half scale of a page from Captain Wilkins' notebook on the flight to Spitsbergen.

hence I decided to do without the aperiodic compass and make use of the eight-inch lifeboat compass already in my possession. The navigator's cockpit was also provided with a prismatic surveyor's compass, a British Royal Air Force bubble sextant, a pocket sextant, a Pioneer Instrument Company's drift indicator, a course-and-distance calculator, protractors—one arranged to serve as an azimuth circle—charts, log books, tables, design curves cut in celluloid, nautical almanacs, etc. (the charts, tables, and curves were those specially prepared by Mr. O. M. Miller, of the American Geographical Society's School of Surveying, for the use of the Detroit Arctic Expedition in 1926).

In theory the navigation of a course between Barrow and Spitsbergen was complicated, and its complications were magnified by the fact that we planned to swing to the east and not to follow a meridian of longitude north to the pole and south to Spitsbergen. On the course we planned to follow we should cross through 171 degrees of longitude and through a difference of 315 degrees of compass declination; and this in an area where the horizontal forces influencing the compass were small and perpendicular forces strong and unknown. The course plotted was a great circle course for the first 1300 miles, then it turned obliquely to the left on another great circle course for 900

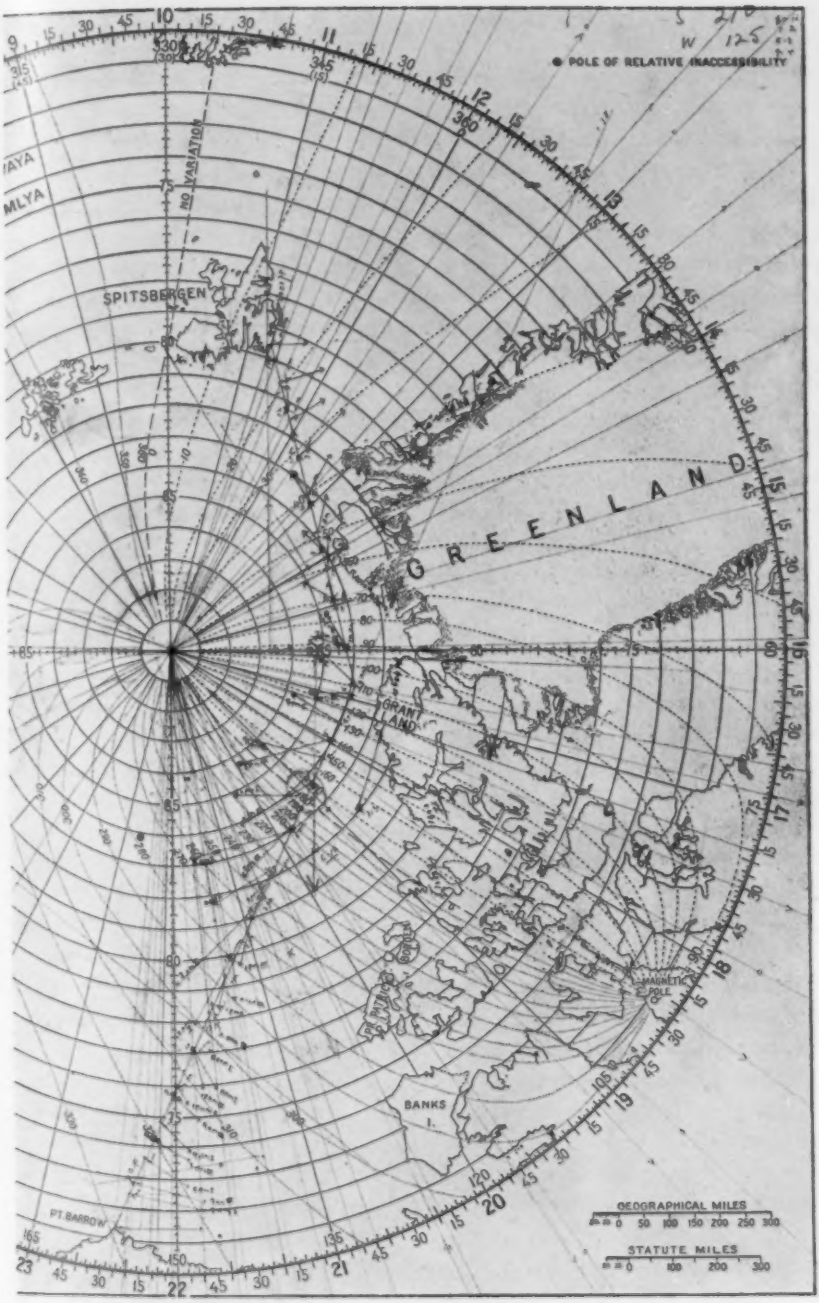


FIG. 16—Reduced facsimile of portion of arc of the actual charts used. A few of the position lines as plotted by Wilkins during the flight can be faintly discerned. The course shown with sun bearings along the route was plotted before starting and assured a particular time of starting and a constant rate of speed throughout the journey.

miles—2200 miles in all. I planned to make it in legs of one hundred miles, changing our course about every hour according to ground speed and meteorological conditions encountered. At first it appeared that the complications would make the steering of a compass course an impossibility, but I found on carefully working out the track, applying the corrections required for declination and the frequent change of longitude, that it would not be so difficult. The greatest change in our compass course would need to be during our ninth and twelfth hours of flight, but the greatest change in any one hour would not exceed twenty-five degrees. The actual change in direction of flight between the start and finish of our journey would be great. The first leg of our course would be in a direction only 18 degrees east of true north: on the last leg we should be flying only a few degrees east of south. It was a question as to whether our compasses would work at all in the air in some of the areas through which we should pass. But I hoped by means of keeping a careful check on drift and ground speed and by obtaining both altitudes and azimuths of the sun to be able to find the way.

Most of the actual notes of observations for drift and ground speed were lost on Dead Man's Island. The notes of changes of courses were passed to Eielson on the end of a long stick and were either thrown overboard by him at once or were later thrown out of the forward cockpit. These notes were generally a request to "steer five or ten or so many degrees to the right or left" as the situation demanded. Because Eielson's compasses were not always steady, I would hammer on the gas tank to let him know when he was on the right course. He would then, by "lining up" on some object in the sky or on the ice, keep the course until again asked to change direction.

The compass courses for each leg of the journey had been carefully worked out before leaving Point Barrow. At each observed position a new departure was taken and the course mentally calculated. After several observations had been taken it was seen that the compass was more or less correct and if necessary we could have steered a successful course by it alone. The checks, however, upon which I depended most for keeping in the right direction were the azimuth of the sun and the distant cloud conditions, which owing to the nature of the weather that day made the navigation of the flight comparatively easy.

During the flight, with the exception of the last two hours, it was always possible for me to see the sun and take observations for altitude (see Appendix A). The course as planned and the course followed as deduced from the astronomical observations are plotted together on Figure 18. I was not always guided by the observed position but sometimes compromised between the position obtained by the sun's altitude and the position estimated by dead reckoning.

No pilot will steer an absolutely accurate course. During odd moments the machine may swing off twenty to forty degrees and back again. Air speeds are a check; but often in our experience it was necessary to climb steeply to warm the engine, and at those times our air speed did not serve to give us an idea of speed over the ice. Again, it would be necessary to side-slip to lose altitude; and, although it was nearly always possible to take observations for ground speed and drift when the machine was level and in straight flight, the speed gained during the dives cannot be registered. I think it is hardly possible for any navigator to bring back an absolutely full and complete check on the direction and speed of a flight lasting for twenty hours and through a wide variety of conditions. It is my experience that a navigator gains through actual experience an ability to compensate for slight changes in direction, speed, and altitude in a manner that no amount of figuring could master.

During our stay on Dead Man's Island we were able to get several sights of the sun, and these placed us somewhere in the neighborhood in which we were. We knew that we were within a few miles of either Kings Bay or Green Harbor and felt sure that if we could get into the air on a clear day we could from an altitude recognize the country. When the weather cleared so that we could see something of the landscape, we were too busy clearing a runway to make observations; hence it was not until we were actually in the air and saw the radio masts at Green Harbor about twenty miles distant that we were certain that we were near Ice Fiord. It took but a few minutes for us to reach the radio station and to land and verify our position.

Summary

In summing up the conditions in the Arctic in relation to aircraft, my experience leads me to believe that both airplanes and airships may be used with safety at certain times of the year even without preliminary ground preparation. With adequate ground preparation aircraft may be used to traverse the Arctic at any season of the year. If the journey is to be one of exploration, then to reap the advantage of good visibility on the ground it is necessary to carry out the work, on the Alaskan side at least, during the months of March, April, and the first half of May. After that time the ground is likely to be obscured by low cloud and fog. I believe that airplanes with normal loads might find anywhere within a radius of 20 miles suitable ice conditions for landing on the Alaskan side of the pole. Conditions are not so favorable on the Spitsbergen side. I believe that men might be safely let down from an airship to the ice, either by taking advantage of a wind to counteract the steering way of the ship or by using a drag-rope anchor. I do not believe that any form of sea anchor would meet

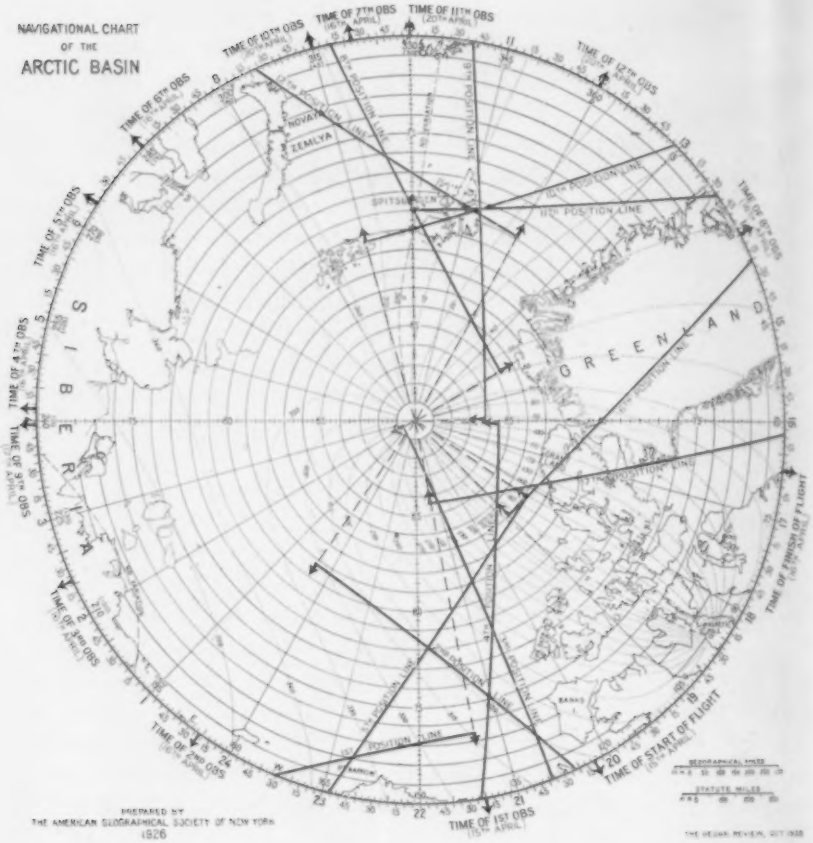


FIG. 17

OBSERVATION	DATE AND GREENWICH APPARENT CIVIL TIME	OBSERVED ALTITUDE	SUN'S DECLINATION	POLAR DISTANCE OF POSITION LINE ON SUN'S MERIDIAN	DEDUCED GROUND SPEED IN STATUTE MILES PER HOUR
Flight begun	15/4 $20^H\ 10^M$				
No. 1	15/4 $21^H\ 20^M$	26° 30′	9° 54′	+16° 36′	111
No. 2	16/4 $0^H\ 22^M$	19° 11′	9° 57′	+ 9° 14′	117
No. 3	16/4 $2^H\ 22\frac{1}{2}^M$	10° 48′	10° 00′	+ 0° 48′	122
No. 4	16/4 $4^H\ 07\frac{1}{2}^M$	5° 32′	10° 00′	− 4° 28′	106
No. 5	16/4 $6^H\ 16\frac{1}{2}^M$	2° 50′	10° 02′	− 7° 12′	88
No. 6	16/4 $7^H\ 0^M$	3° 00′	10° 03′	− 7° 03′	87
No. 7	16/4 $9^H\ 25^M$	5° 35′	10° 05′	− 4° 30′	
No. 8	16/4 $14^H\ 04^M$	15° 32′	10° 10′	+ 5° 22′	129
Flight ended	16/4 $16^H\ 30^M$				197
No. 9	17/4 $3^H\ 58^M$	6° 37′	10° 21′	− 3′ −44′	
No. 10	20/4 $9^H\ 0^M$	21° 07′	11° 29′	+ 9° −38′	
No. 11	20/4 $10^H\ 0^M$	22° 30′	11° 30′	+11° −00′	
No. 12	20/4 $12^H\ 0^M$	22° 35′	11° 32′	+11° −03′	

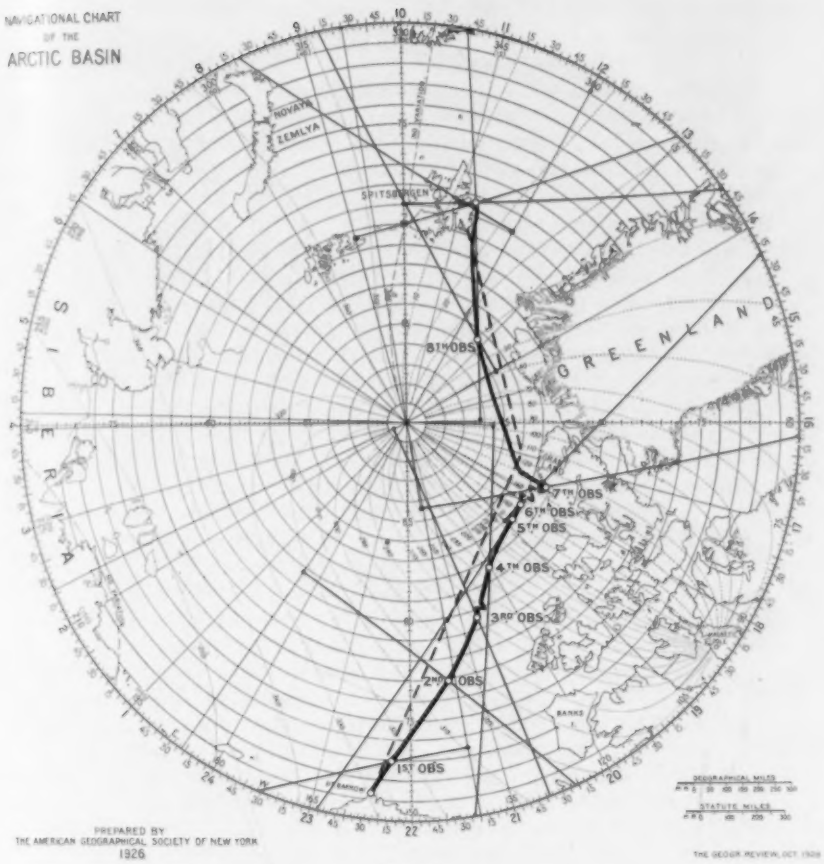


FIG. 18

FIGS. 17 and 18—Figure 17 shows the position lines plotted on the chart, which is a stereographic projection. It demonstrates the ease of the method employed. The time of observation having been marked on the perimeter of the chart, the latter acting as a 24-hour clock, the meridian over which the sun was crossing when observed is automatically determined. The distance from the pole where the position line, namely the equal altitude circle, cuts this meridian is shown in the adjoining table and is equal to the observed altitude minus the sun's declination. The position lines are actually drawn by means of suitable curves cut in celluloid, the most correct curve of a series of ten being chosen from a table with altitude and declination as arguments.

Figure 18 also shows the position lines but emphasizes the course actually flown (heavy solid line: the course laid out is dashed) as deduced from the astronomical observations and the dead reckoning. Where the course is shown as a zigzag (just after the 3rd observation and between the 6th and 7th observations) it is diagrammatic, as it is based on the narrative of the flight only.

all conditions. It would be useful on occasion; and both types of anchor should, if possible, be carried. It appears likely that ice sufficiently stable to accommodate a permanent party can be found in the Arctic, but the housings and equipment of that party should be as portable as possible.

APPENDIX A—REPORT ON THE ASTRONOMICAL OBSERVATIONS

O. M. Miller

The writer has studied Captain Sir Hubert Wilkins' actual record of astronomical observations taken on the Point Barrow to Spitsbergen flight and, after plotting the results freed from certain slight errors to be mentioned later, finds in them close corroboration of the statement that Wilkins flew within a few miles of the course laid out and that he thus accomplished a feat in navigation which can be confidently declared unparalleled in the history of flying.

The extreme difficulty of navigating in the polar regions across meridians instead of along them, especially when the magnetic declination is changing rapidly and the horizontal component of the earth's magnetism is weak, has already been explained.

It was owing to Wilkins' careful preparations and his skill and experience in navigating that he succeeded in keeping close to his intended course. It was not found necessary to place full reliance on the astronomical work during the flight and, because of an error of one hour in recording the time of one of the observations and owing to one or two slight mistakes in extracting the sun's declination, the excellence of the astronomical observations was not fully appreciated till later.

Wilkins made eight sets of altitude observations on the sun while he was in flight and four from the ground while at Dead Man's Island. These observations were recorded in a book specially prepared by the American Geographical Society for navigation in the polar regions (see Fig. 15 for specimen sheet). The position lines deduced were then plotted on the navigational chart immediately (see reduced facsimile, Fig. 16). The observations consist mostly of sets of five or six sun altitudes taken in rapid succession corrected for refraction to the nearest 5′ only. The probable errors of their means vary from ± 4′ to ± 14′.

Referring to Figure 17, it is of interest to note the effect of the position of the sun during the flight. Observations 1, 3, 4, and 8 give good checks on both distance flown and direction. The accuracy of observation 8 is corroborated by the statement in Wilkins' notes that at "3 a. m." (13^{H} G.A.C.T.) he was "abreast of end of Greenland." Observation 2 gives an excellent determination of distance flown, for when it was made the sun was dead behind the direction of flight. Observation 7 leaves little doubt as to the part of Grant Land flown over. Observations 5 and 6 are good checks on direction. The position lines deduced from observations 9, 10, and 11 all meet at a point on the southern edge of Dead Man's Island. The only observation obviously at fault is the last one.

APPENDIX B—FINANCES, EQUIPMENT, AND PERSONNEL

Expedition of 1926

The amount of my personal available funds, $15,000, was the nucleus of the 1926 Expedition. For exclusive right to have one of their staff accompany the expedition and record the daily happenings, the North American Newspaper Alliance agreed to pay $25,000. The *Detroit Times*, not a member of the Alliance, paid for the privilege of printing the news simultaneously with the members of the Alliance a sum of about $4000. The Richfield Oil Company of Los Angeles agreed not only to provide the gasoline required but to subscribe $5000 cash. The Pennzoil Company gave all the oil required and a sum of $1500. Pathé News agreed to pay $2500 cash and provide the staff, equipment, and traveling expenses in connection with the photographic record of the Expedition. The American Geographical Society, in addition to its scientific advice and support, subscribed $1000 in cash and the maps, special notebooks, tables, watches, etc. for the use of the navigator. In all $50,000 and much equipment became available.

The Detroit Aviation Society, anticipating aid from the citizens of Detroit, guaranteed all other necessary funds. The original estimate of funds required was about $95,000, but later the purchase of a second machine for $25,000 brought the figure to approximately $120,000. In order to pay cash for the equipment required, several members of the Detroit Aviation Society, some of whom were also members of the Expedition Board of Control and the Finance Committee, agreed to borrow from a bank at a nominal rate of interest the money required, hoping of course that the amount borrowed would be more than covered by popular subscription. In this they were disappointed.

The equipment selected for the 1926 expedition included one trimotored Fokker monoplane, powered with Wright Whirlwind engines, and one Liberty-engined Fokker monoplane. The Wright Aeronautical Corporation, of Paterson, N. J., provided three specially selected engines at a discount and made available, to be paid for only if used, a fourth engine. The three-engined monoplane, the first to be made of that size, 73 feet span, was manufactured in Holland and assembled at the Atlantic Aircraft Corporation factory at Hasbrouck Heights, N. J. The Liberty-engined machine had a 63 foot wing. A spare Liberty engine for this machine was the gift of Mr. Henry Ford. Adequate engine and airplane spares and complete tools for repairs and assembly were provided. Mr. Johnston, of Johnston Motors, Ltd., New York, presented a complete set of spare parts for the Liberty engines.

Each machine was fitted with wheels and carried a spare wheel, tires, and tubes. One spare landing gear was provided. Two sets of skis, to be attached to the axles beside the wheels, were provided. These detachable skis were expected to be used only on the trial flights and the flights from Fairbanks to Barrow.

The B. G. Corporation contributed all spark plugs and extras required. The Curtiss Reed Propeller Company provided a set of their propellers at minimum cost. Lieutenant Malcom Hansen, of Washington, D. C., built for the North American Newspaper Alliance a wireless airplane set which could be used either in the air or on the ground.

The personnel of the 1926 expedition included pilots Lieutenant Carl Ben Eielson, who had already flown in Alaska, and Sergeant Charles M. Wisely of Selfridge Field. The Wright Aeronautical Corporation loaned the services of A. Hufford, one of their staff, so that the expedition was relieved of the responsibility of finding a mechanic to service the Wright Whirlwind engines. The Atlantic Aircraft Corporation, in fulfillment of their contract, provided the services of a representative to supervise the assembly and trials of the Fokker planes. Major T. J. Lanphier, commanding officer of the first pursuit group, Selfridge Field, obtained leave to accompany the expedition. The North American Newspaper Alliance and Pathé News sent members of their own staffs to attend to the matter of collecting and forwarding news and pictures. The publicity section was quite separate and apart from the expedition, although naturally we welcomed the aid they gave.

Expedition of 1927

The bills of the 1926 expedition, including the expenses in connection with the snow-motor and dog-team party—not mentioned in the above account as it made no contribution to the effective work of the expedition—amounted to about $120,000. The estimated value of the equipment on hand at the end of 1926 was $30,000, in half of which property the Detroit Aviation Society rightfully owned an interest. At a meeting of the Detroit Aviation Society and the Expedition Finance Committee in November, 1926, it was resolved in effect that if I agreed to pay the Detroit Aviation Society 20 per cent of my earnings from future expeditions until $30,000 had been paid I might make use of the expedition's property and look elsewhere for further support. It should here be noted that at the termination of the 1928 efforts the

Detroit Aviation Society, with the understanding that all my earnings were to go toward financing an Antarctic expedition, very generously relieved me of all financial responsibility toward the Society.

Such was the financial position in November, 1926, when the Detroit News came forward and offered me $5000 for payment for the use of the expedition film and my services as a lecturer at 106 lecture engagements, which sum I agreed to pay into the funds for a new expedition. The Detroit News then most generously agreed, if I provided the equipment, to pay all the working expenses of the new expedition which was to be called "The Detroit News-Wilkins Expedition." The American Geographical Society provided at considerable expense a sonic depth-finding apparatus. The North American Newspaper Alliance was given the sole right of news, and while they gave no money to the expedition they agreed to send their representative at their own expense. The estimate of the costs for running expenses was $12,000.

After going carefully into performance figures it was decided to purchase for the 1927 expedition one Stinson Detroit biplane equipped with tank capacity of 225 gallons. The Stinson would serve for the short flights northeast and northwest of Point Barrow. For the flight to Spitsbergen it was intended to use the larger Fokker wing fitted to a Liberty engine and fuselage. There was sufficient condensed food and clothing left over from 1926, and as I had shipped 1500 gallons of gasoline and 150 gallons of oil to Point Barrow during the summer of 1926 there was no need to freight these supplies from Fairbanks.

The Detroit News generously loaned a second Stinson biplane. Thus we were provided with two Stinson machines supposed to be interchangeable in every part except the engine; the engines could be changed *en bloc*. We had skis and spares for the Fokker machine at Fairbanks and Point Barrow.

Carl Ben Eielson again accompanied the expedition as chief pilot. A second pilot was obtained in Alger Graham, late of the Stinson Aircraft Corporation, Detroit. The Detroit News sent their own representative in Mr. A. A. Smith, and the North American Newspaper Alliance provided two wireless operators.

Expedition of 1928

For the 1928 expedition I determined to carry out as far as personnel and equipment were concerned the ideas I had in 1926 before I was overpersuaded to take a big expedition with a number of men and duplicate airplanes. I would select the fastest plane capable of carrying the necessary polar sledging gear, sounding apparatus, and other scientific and navigational equipment, two months' food supply, a radio outfit, one pilot, and enough gasoline to cover a distance of 2700 miles. In previous years the services of mechanics had been engaged; but this time I decided to be my own mechanic and besides attending to the business details, the navigation and preparation, to look after the engine myself.

The return from the sale of the Fokker machine brought in less than $10,000 clear. I received a little less than $10,000 for the Stinson biplane. The cost of the Lockheed Vega standard machine that I selected as the plane for my purposes was $12,500; but, what with the extra instruments, spares, transportation, etc., the actual expenses in connection with the machine were much more. A short-wave radio set was provided at an expense of over $1000, and incidental expenses brought the total amount to more than $20,000. For the privilege of having the trade signs painted on the machine the Richfield Oil Company paid $1000, and the Pennzoil Company $750. A kind friend in Los Angeles, who wishes to remain anonymous, subscribed $500, and the late James B. Ford, through Dr. Isaiah Bowman of the American Geographical Society, made available $600. I provided a further $3000

of my own money and so by doing without financial backing from any newspaper syndicate I was able to avoid the necessity of preliminary publicity.

The Lockheed Vega plane was of standard cabin design with just a few alterations for the convenience of Arctic navigation and for the accommodation of sufficient gasoline and supplies. In detail they amounted to a different distribution of windows, an arrangement to give maximum light in the navigator's cabin and to facilitate his ability to take observations of the sun and for drift and ground speed. This necessitated two windows in the floor and so allowed constant observation. An addition was made to the instrument board in front of the pilot. It held—besides the ordinary tachometer, thermometer pressure gauge, altimeter, air-speed indicator, and watch—an additional altimeter registering accurately to two feet, a turn-and-bank indicator, a fore-and-aft inclinometer, a lateral inclinometer, one fast-moving compass, and one slow-moving compass.

Our equipment included—besides the two sets of sounding gear, water-sample bottles, deep-sea thermometers, and snappers for obtaining bottom samples—combined seal spear and ice chisel, an axe, a small alpine axe, an apparatus for securing seals from the water, two rifles, 350 cartridges, 3 snow knives, a saw, two pairs of snowshoes, two half sleeping bags with waterproof covers, strips of deerskin to place beneath our bags, a wind-proof and waterproof tent with a waterproof flooring, straps for making packs of our sleeping bags, a duraluminum-shod runner which we could fix to the upper part of the fuselage and so construct a sled canoe in case of an accident to our machine, a Primus stove, two cooking pots, cups, plates, and spoons, four half-gallon containers for fuel, one of them filled with alcohol, another filled with ether to be used either for starting the engine in cold weather or in case surgical operations following an accident were necessary, bandages, medicines, a complete field surgical outfit, a small quantity of tobacco and some coca leaves to be used for alleviating hunger, two canvas covers for the engine and special stoves for heating them, fishhooks, fish nets, and sinkers. The fish net could also be used on the end of the seal spear for netting small auks and other birds should we find ourselves marooned on one of the Arctic islands. Our spare clothing with what we wore provided for each man two fur shirts, two pairs of fur socks, fur breeches, sealskin breeches, one pair of cloth breeches, four pairs of Angora woolen socks, two pairs of sealskin winter boots, two pairs of sealskin summer waterproof boots, two pairs of fur mittens, one pair of waterproof mittens, silk snow shirts and silk snow trousers, tooth brushes, tooth paste, hair clippers, safety razors and shaving cream, soap and a towel, a small mirror, a small pocket compass, sheath knives and small files for sharpening them, a magnifying glass, a waterproof box for matches, handkerchiefs, a sewing kit, silk and sinew for repairing boots and skin clothing, two pairs of snow glasses, and a Primus bottle.

For food we carried five pounds of sweet chocolate, twenty pounds of biscuits, twenty pounds of pemmican, twenty-four pounds of malted milk in tablet form, and five pounds of raisins.

ARCTIC WEATHER OF APRIL 15–16, 1928

WITH SOME OBSERVATIONS ON POLAR WEATHER IN RELATION TO THE GENERAL CIRCULATION

Sir Napier Shaw

THE reports of Sir Hubert Wilkins' flight across the polar region from Point Barrow to Spitsbergen and the additional information obtained from the Geophysical Institute of Tromsö give a flash-light picture of polar weather in April. Keeping the geographical pole on the left and the magnetic pole on the right, the course passed within 350 sea miles of the chief center of geographical attraction. It is an interesting region for a geographer to traverse; the deviation of the north point of the compass from the geographic north, what sea folk call the "variation," changed through 313°, from 330° "west of north" at the start (compass pointing 30° E. of N.) at Point Barrow to 17° west at Spitsbergen. The flight from Point Barrow to the first landing at Spitsbergen took 20¼ hours of impartial civil time, but it would count as a day and a quarter, 30¾ hours, according to true solar time as kept by sailors at sea.

Polarity of Weather

The region has also a special interest from the meteorological point of view. All the well-known theories of the general circulation of the atmosphere—Maury's or James Thomson's or Ferrel's and even V. Bjerknes' and, with a dislocation of the northern pole from 90° to somewhere in Greenland, W. H. Hobbs's also—are zonal and have a certain symmetry about the pole. The question naturally arises, "Is there really a meteorological pole about which weather is symmetrical?" And if so, "Is it really centered by the rotation of the earth at the geographic pole or is it somewhere like the magnetic pole not actually coincident but still near enough to be regarded as paying at least a proper respect to the earth's rotation?"

Meteorologists are not quite agreed about the polarity of weather. If I have rightly understood what I have read, there is a view that, in so far as the earth's atmosphere is left in peace and quietness, it would settle down with cold air over the polar regions and warm air over the rest of the world, with a well-defined surface of separation between the two which marks a discontinuity of temperature and wind and which arranges itself as a conical or [cylindrical] surface with its axis coincident with the earth's true axis. Its boundary meets the

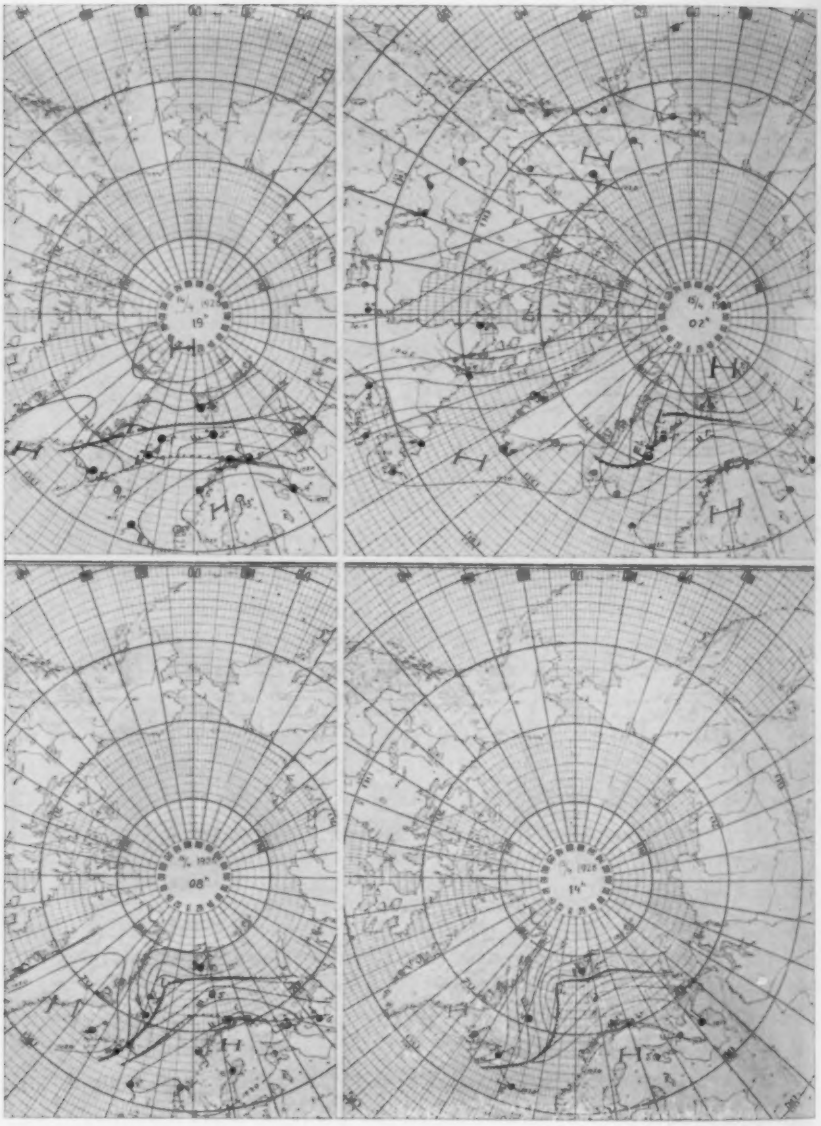
earth's surface at a small inclination somewhere about latitude 60°. The sweet simplicity of the ideal arrangement is sadly impaired by "the slings and arrows" of the weather; still the discontinuity between equatorial and polar air, to which nature is forever addicted and is always trying to set up, can be recognized wherever it can be found on a map. We see it in the separation of warm and cold air in a cyclonic depression; indeed, according to this view, a cyclonic depression in its inception is nature's own reaction against the existence of the discontinuity—her own creation. In actual practice the discontinuity demonstrates itself in the form of bursts of cold polar air bulging and spreading southward between successive cylconic depressions.

Summing up briefly, the polar-equatorial discontinuity is an inherent characteristic of the earth's atmosphere and its rotation; it is disturbed but not destroyed by atmospheric convolutions; it is at once the condition precedent of the formation of a centralized depression and the condition to which the atmosphere will return when the depression has worn itself out.

There is another view, namely that the bulges or surges of cold air and such lines of discontinuity as are found on maps, between them and the warm air which they invade, are the ultimate consequence of the chilling effect of "slope" in the polar regions—chilling in the polar winter on account of the radiation to the sky in the polar night and chilling also in the summer, in spite of the long hours of gentle sunshine, on account of the accumulation of snow and ice on the polar slopes.

By an inexorable law of convection cold air will go down chilled slopes, and the "slope effect" (which is in itself the real part of land and sea breezes) will provide an inexhaustible supply of cold air to the surface of the Arctic region in winter and summer but especially in winter and early spring. What extent or steepness of slope is necessary to keep up a measured supply is still undetermined; and how many of the land areas of the polar regions are efficient purveyors of cold air is also a matter for consideration. The tundras of the Asiatic coast line and of the Barren Grounds of northern Canada count for little. Alaska counts for a good deal, and Greenland for so much that it may perhaps be considered as Nature's effort to provide a weather pole in the north, as Hobbs pictures it, that, like the magnetic pole, shall not be simply subservient to the universal general.

Emphatically we may assert that the air of the north polar regions is not independent of the general circulation; it is certainly not exempt from the tyranny of pressure; the equator is the better place for that kind of freedom. We can hardly conceive of increase of pressure except as convergence of upper air, using its velocity to provide the necessary compensation for the destruction of pressure difference which is the inevitable consequence of the drift of air from high pres-



sure to low at the surface. From that point of view the Arctic basin is rather a good theater for the staging of a high-pressure drama by the general circulation; the local influences we can only regard as humble but very amusing players, like Nick Bottom and his friends in "A Midsummer Night's Dream."

In the *Monthly Weather Review*[1] A. J. Henry has been asking where

[1] A. J. Henry: Whence Come Cold Waves?, *Monthly Weather Rev.*, April, 1928, pp. 142–144: reference on p. 144.

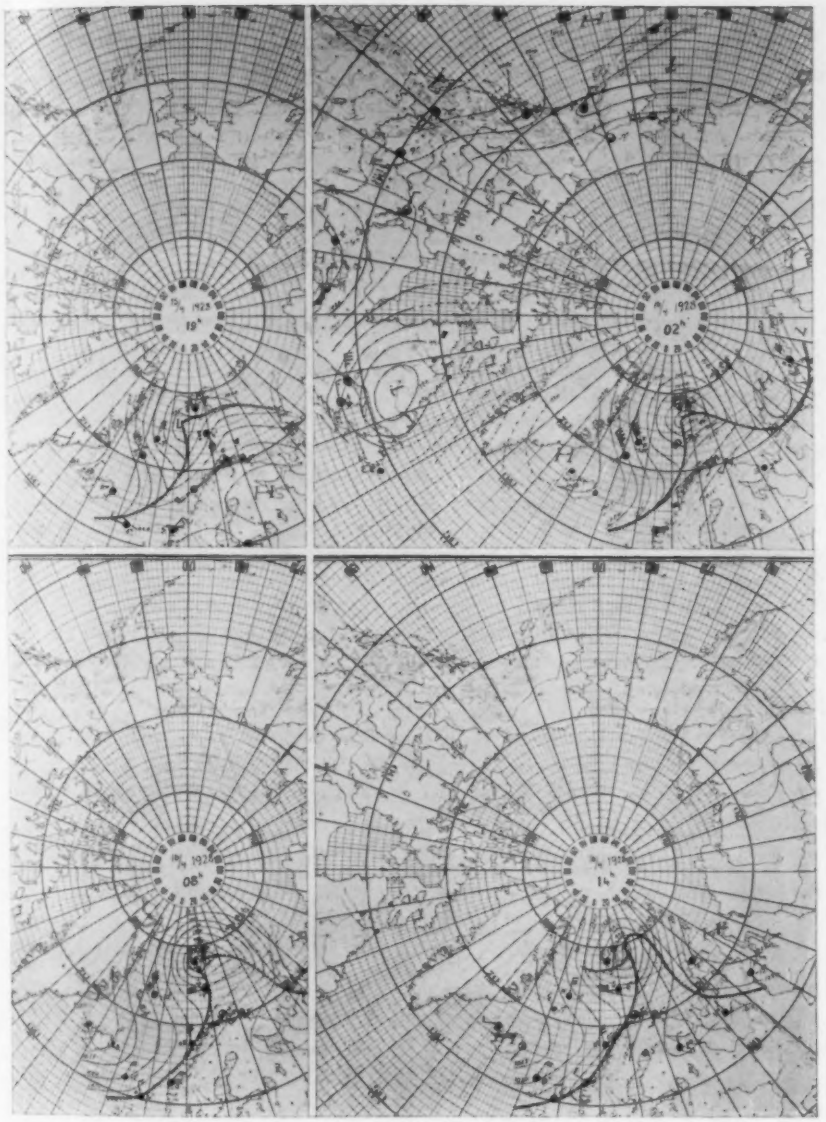


FIG. 1.—Reproduction on a reduced scale of weather charts furnished by the Director of the Geophysical Institute at Tromsö for 19 h. April 14 (Central European time) to 14 h. April 16, 1928, showing the development of the storm over Spitsbergen in which Captain Wilkins landed. For a diagrammatic representation of the advance of the cold front see Figure 2.

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the cold waves come from and uses the international data for 1882–1883 for the Arctic for his information. He says:

> In conclusion it may be said, for North America at least, the evidence of the three international Polar stations is against the idea that aperiodic thrusts of cold air Equatorward take place, and that even under a more favorable distribution of reporting stations than now exists it would be difficult to identify any particular thrust with a subsequent cold wave in temperate latitudes. The cold waves of the latter region, if we may express a belief based on many years experience with the daily weather charts, are doubtless due to an initial southward movement of air which takes place in accordance with the pressure distribution of the moment, most probably about north latitude, say, 60° to 70°, but not necessarily within the polar basin, plus the effect of intense radiation from the snow and ice-covered surface of the continental interior.
>
> The evidence of the Fort Rae station—a station situated, if not within the place of origin of cold waves, yet very close thereto—is adverse to the concept of an outbreak or thrust of cold polar air Equatorward. The speed of the wind at that station on the average of the three winter months is but 1.8 meters per second (4 miles per hour), and high winds are conspicuous by their absence. During the coldest days of the months, November to March, the prevailing wind direction was NNW., although it was calm an equal number of hours. The next most frequent wind direction was SSE., or in the exact opposite direction. The winds from the last named were equally cold with those from a northerly quarter, thus indicating a thorough mixing of the lower layers and a sort of equilibrium temperature after a day or so of northerly winds. Although the Point Barrow station is 18° farther north, the temperatures registered thereat are somewhat higher than at Fort Rae in the cold season.
>
> It is quite probable that cold waves entering the North American Continent by way of the Mackenzie River Valley may have had their place of origin in extreme northeastern Siberia, in the valley of the Anadyr River. A movement thence to western Alaska is but a short journey and almost wholly over a land surface.

Bearing these things in mind let us look at Sir Hubert Wilkins' records. He sailed (in the air) with light or very light head wind or no wind at all for 1000 miles. Off Grant Land at 08 G. C. T. of the 16th at 3000 feet he got into a light northwest wind, which represented a general flow from the polar region round a cyclonic center over Spitsbergen that had set itself up in the interval from 18h. of April 14.

Six hours later he was within 200 miles of Spitsbergen and on the way to the center of a storm which had been visible in the distance for four hours and had developed a very unwelcome intensity.

The Tromsö Charts

The Geophysical Institute at Tromsö has supplied charts for April 14, 18h; 15, 1h, 7h, 13h, 18h; 16, 1h, 7h, 13h, G. C. T., in which the separation of polar air from equatorial air is marked. The progress of the cold and warm fronts is indicated by the charts. The story begins with a line of discontinuity running along the shore of the Denmark Strait to the center of a "low" at the eastward extension

of Greenland and from there onward passing just south of Spitsbergen to Novaya Zemlya. The part along the Greenland coast is a "cold front" facing east-southeast, the continuation of the same line to Novaya Zemlya is the boundary of equatorial air forming a warm front facing northwest. The winds of the equatorial air represent in effect a flow of air supplied from the southwest covering the whole of the Greenland Sea and with a light air running slowly eastward on one side of the discontinuity while on the other side polar air coming from Novaya Zemlya moves past Spitsbergen towards Greenland. Just off the Greenland coast, with a northerly wind on its left and a northeaster on its right, is the beginning of a "low" which separates the polar air that is flowing off Greenland from the equatorial air that is moving over the sea.

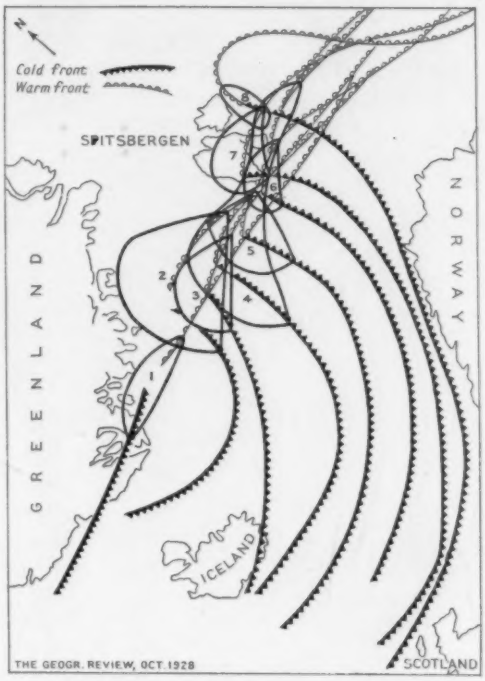

FIG. 2—Chart of the march of the cold front from Greenland to the Norwegian coast from April 14, 18 h. (G. C. T.) to April 16, 13 h. (G. C. T.), based on the charts of Fig. 1. The storm center for the successive 6-hour intervals is shown by numbers 1 to 8. The pressure falls from 1005 millibars at 18 h. April 14 to 985 millibars at 14 h. April 16.

Successive maps show the cold front as the bulging eastward of the air from Greenland, which gets stronger as the cyclone develops and is reinforced by air coming from above latitude 80° and curling into the very strongly developed depression. In the meantime there is rain or heavy snow within the area of the low, especially in Spitsbergen. In the course of the advance of the cold front from the Greenland coast the whole of the Greenland Sea south of Spitsbergen up to the Norwegian coast is swept clear of equatorial air; but there is hardly any advance of equatorial air northward. The cyclone, which was so violent that a wireless operator at Kings Bay lost his life in an attempt to make a short distance out of doors, moved its center only slowly.

Altogether the flash-light picture shows that on this particular occasion the idea of Greenland as a weather pole for supplying cold air scores. The storm took two days to develop. In the course of a year there is time for nearly two hundred of such flash-light photo-

graphs. In this particular one, slope effect and rain or snowfall are prominent. Slope effect is one aspect of convection, and rainfall or snowfall is another. Let me here remark that we are thus entitled to regard convection as an important meteorological factor.

I have lately been disposed to study the general circulation of the atmosphere from the point of view of our knowledge of convection;

FIG. 3—Map of the normal distribution of rainfall and cloud over the northern hemisphere in the month of April, with lines showing the normal distribution of pressure in millibars. The heavy ruling represents rainfall greater than 100 millimeters (4 inches); the lighter ruling, cloudiness greater than 7 over land or sea; the close stipple, rainfall less than 25 millimeters (1 inch); open stipple, cloudiness less than 2 over land and less than 5 over sea.

and the events of April 14 to 16 would suggest that Greenland, on account of its slope, is a sort of pole of downward convection and Spitsbergen a center of upward convection. Whether the slopes of Spitsbergen are sufficient to give it on other occasions a local polarity is a question more easily asked than answered; but this occasion invites us to pursue somewhat further the relation of convection to the general circulation.

The Distribution of Rainfall as a Guide to the General Circulation of the Atmosphere

Convection as a meteorological agent has not yet been studied to the extent which it deserves. It has been thrown into the theories of the general circulation and assumed to belong to the hypothetical

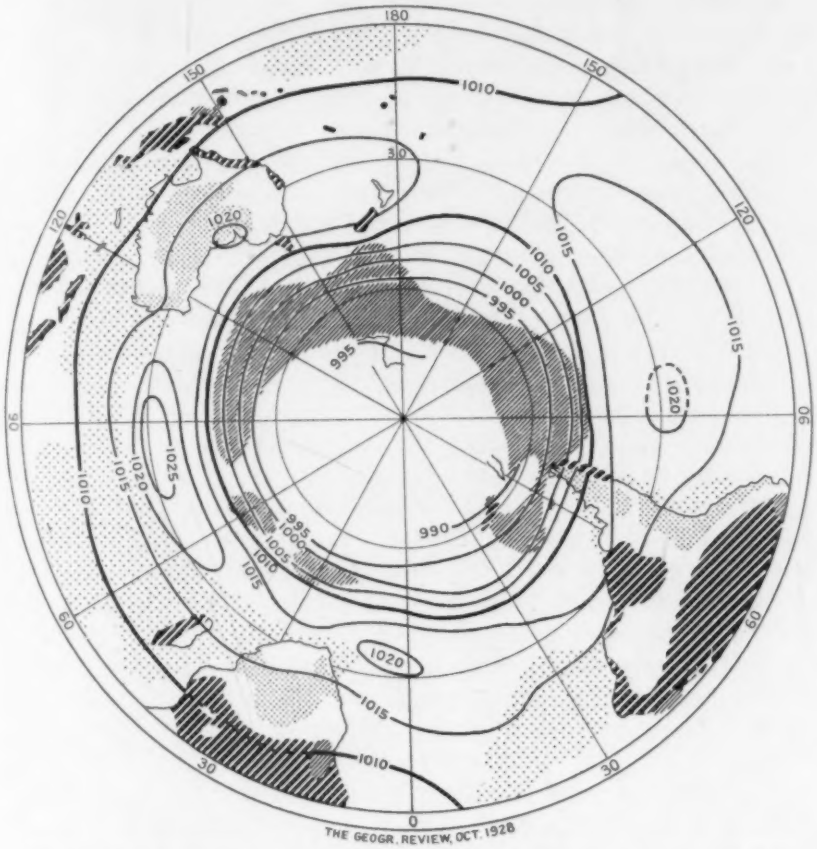

FIG. 4—Map of the normal distribution of rainfall and cloud and pressure over the southern hemisphere in the month of April. See Figure 3 for explanation of symbols.

zonal distribution without any adequate examination of its capacity or its limitations.

If we allow that convection is the controlling principle of the general circulation the subject may be approached in a reasonable way by examining such data as there are for evidence of convection and its distribution over the globe and fitting in the general circulation to the facts as thus elicited instead of assuming a general circulation on a zonal plan and tossing in the convection as a life buoy to keep the theory afloat.

Copious rainfall may be accepted as substantial evidence of upward convection of saturated air in the atmosphere not far from the locality where the rain is registered. So a map of the distribution of rainfall over the globe is at the same time a map of the distribution of convection. The upward convection may indeed be regarded as proportional to the rainfall. Where there is no rainfall there is no upward convection in the sense in which we use the word with reference to the general circulation, and where there is much rainfall there must have been much convection in the same sense. Upward convection implies convergence or advection to supply the place of the air which has gone upward, and advection in one locality implies downward convection and "divection" in another with horizontal movement between the two to complete the circulation. Orbis terrarum in tres partes divisus est: regiones advectivas sive convectivas, regiones divectivas, et regiones intervenientes sive medias.

Using rainfall as an index of upward convection and the absence of rainfall as an index of the possibility of downward convection, we can divide the surface of the earth into advective regions where there is relatively heavy rainfall, divective regions within which the air comes down and from which it is distributed over the surface, and the intervening regions over which the air passes from the divective regions to the advective regions.

On a synchronous chart of the distributions of pressure and wind, anticyclones, where there is little or no rain, appear as divective regions, and cyclones which are generally rainy as advective regions. So it may be on maps of the normal distribution of pressure; areas of high pressure may be associated as divective regions with areas of low pressure as advective regions with intervening regions of straight isobars marking localities of variable winds with resultant flow from a divective center towards an advective center.

To test this suggestion I have tried to use maps of the distribution of rainfall as a guide to the advective and divective regions.

Provisionally I have taken a monthly fall of more than 100 mm., 4 inches, as a mark of identification of an advective region where air ascends and similarly a fall of less than 25 mm., 1 inch, as the mark of a divective region where air descends. Superposing them on a map of the distribution of pressure the suggestion will be confirmed if in the normal there is high pressure in the divective region and low pressure in the advective areas. The isobars of the intervening areas will show the direction of flow.

We have monthly maps of rainfall over the land but most unfortunately none over the sea; and the world with the sea left out is not good enough. However, we have figures for cloudiness over the sea as well as the land, and there should be some connection between normal cloudiness and normal rainfall. So I have made an attempt

at guessing a relation that would enable me to identify advective and divective regions.

On the coasts, cloudiness 7 works in pretty well with a rainfall on the land of 100 mm. So over the sea we may try cloudiness greater than 7, as a provisional index of an advective region. For the divective regions things are not so simply arranged. Over land rainfall less than 25 mm. seems to go with cloudiness 2; but over the sea there is no region with so low a figure. Cloudiness less than 5 is more rare than rainfall over land less than 25 mm. So as a first experiment I have tried cloudiness less than 5 as the index of a divective region over the sea.

It is not only the sea for which suitable data are lacking; there are the polar regions for which we have no adequate information about rainfall or cloud, and for these localities we meet with a special difficulty about the equivalence of the two on account of fog. A fog at sea that prevents an observer from seeing anything else is logged as cloudiness 10, the same as overcast sky, even if the fog does not reach beyond the masthead. Now fog may be associated with slope effect, or downward convection; but cloudiness 10 would put it in the opposite category. Consequently the small number of data which exist for the Arctic basin afford little or no help in classifying the locality or a part of it as advective or divective. That is a great misfortune.

With all these failings I present a map of the northern and southern hemispheres showing the normal positions of the advective regions, the divective regions, and the intermediate regions for the month of April derived from the maps of normal distribution of rainfall, cloud, and pressure for that month in my "Manual of Meteorology," Vol. 2, Figs. 111–112, 81–82, 138–139. It is suggestive but not exactly conclusive.

Greenland as a Divective Region

From the fact that on April 15–16 air flowed off Greenland to take part in the formation of snow and rain about Spitsbergen we are on safe ground in regarding Greenland as a divective region. Parenthetically, that is, I believe, the real meaning of Professor Hobbs's glacial anticyclone. Spitsbergen may have been an advective one during Wilkins' flight, and the suggestion may quite well rank as a normal experience.

Wilkins saw a storm behind him when he was leaving Point Barrow, another storm over Greenland was visible from Grant Land, and Spitsbergen was enveloped for two days in a storm which he saw from north of Greenland.

There is an interesting passage about cyclonic depressions in these regions in the paper by A. J. Henry to which reference has already been made.

The pressure records at the Point Barrow show that the station is more frequently visited by intense cyclones than might be supposed. The fact that deep cyclonic systems approach the Alaskan coast of the Bering Sea area from the winter pressure minimum of the Aleutians makes it not only probable but certain that at times an intense cyclone passes eastward along the coast of northern Alaska. One such passed close to or over the station on January 12, 1882, having a central minimum pressure of 28.266 inches and winds of hurricane velocity.

Four days later the most severe wind storm in the life of the Fort Conger Station was experienced. The two stations are 1200 miles apart and a travel on the part of the cyclone of but 400 miles a day would accomplish the journey.

Rasmussen in the account of his Arctic travels among the Eskimos has many references to blizzards in winter in the Barren Grounds west of Hudson Bay. Lockyer's maps of isanakatabars (equal ups and downs of pressure on the barogram) in "Manual of Meteorology," Vol. 2, Figs. 204–206, show a zone of maximum range of 19 mm. about 60° in the southern hemisphere and in the northern hemisphere two separate regions of maximum with about the same range, one covering the North Atlantic and its coastal areas from Hudson Bay to Novaya Zemlya, the other smaller area covering the Aleutian Islands, Alaska, and the Bearing Strait.

It is at least curious that the north polar basin and the central north shores of America and Asia are outside the maximum area so that southern Greenland and the Aleutian Isles appear as special centers of conflict between "polar" and equatorial air and probably, therefore, advective regions in comparison with divective regions covering the interior of Greenland and the polar sea.

We must wait for further investigation of the polar basin before we can complete our setting of the general circulation as the expression of convection and its consequences.

MONTE VISTA: SIXTY YEARS OF A COLORADO COMMUNITY

Ralph H. Brown

University of Colorado

MONTE Vista, situated in the western part of the San Luis Valley of Colorado, is a small town of distinctly American stamp bearing but few marks of the long Spanish stewardship of which its name is suggestive.

The rapid recent spread of Middle Western culture in this region anciently identified with kingly land grants and extensive cattle ranches is, indeed, its most striking characteristic. Names of features and places and here and there groups of adobe dwellings occupied by Mexican families are all that remain of Spanish culture in the Monte Vista region. On the other hand, but fifty miles away beneath the towering sierra of the Sangre de Cristo which forms a definite eastern margin to the great San Luis Valley the life of vast Spanish land grants, now managed by Americans, continues in nearly complete isolation. Thus in a half-day's journey by automobile across the nearly featureless plain of an intermontane lowland, whose altitude is over seven thousand feet, one may view a manner of living but little altered by the advance of the American frontier with the plowed fields and settled permanency of the Middle West which in the vicinity of Monte Vista has transformed the landscape.

The Region before Modern Settlement[1]

From 1819, under undisputed Mexican control of the southern part of the state, settlement extended but slowly northward into the Colorado section of the San Luis Valley, partly, no doubt, because of the forbidding aspect of the San Luis Hills which divide the valley into two unequal parts.

Land grants were awarded to notable men who had rendered services in the establishment of the republic. "There was an abundance of land, and so the grants were large; the land had little value, and so frequently no attempt was made to determine accurately the limits of a grant. This loose system of disposing of the public domain was of interest to the United States because by the Treaty of Guadalupe Hidalgo (1848) which ended the Mexican War, our government

[1] See C. B. Goodykoontz: The Exploration and Settlement of Colorado, in "Colorado: Short Studies of Its Past and Present" (Univ. of Colorado Semicentennial Ser. IV), Boulder, 1927, pp. 42–90.

pledged itself to respect valid titles to land in the ceded territory."[2] After the award of the land grants a number of small villages or "plazas" were founded. Thus there appeared in the Sangre de Cristo Grant of 1843, involving a large portion of Costilla County, the settlements of San Luis (1851), San Pablo (1852), and San Acacio (1853). The Luis Maria Baca Grant, confirmed by Congress in 1860, in the northeastern part of the valley, was an outpost of civilization of the Mexican type. The Conejos Grant, in Conejos County, also placed land titles on a more secure foundation, thus removing one cause for retarded settlement. Others such as the Medano and Trinchera brought similar results.

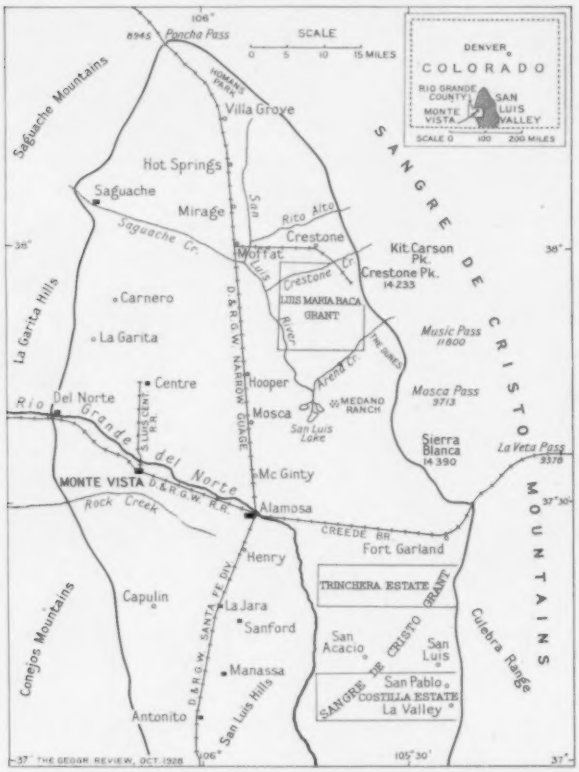

FIG. 1—Location map of Monte Vista, Colorado. Scale 1:1,600,000.

Fur trading added little to the settlement of the region although traders appeared in the valley at least by 1822. Passes across the eastern mountains became known partly through them and by the explorations of Frémont and Pike. The latter in his search for the source of the Red River, crossed the Sangre de Cristo in winter and finally found a large river which he thought to be the Red but was later chagrined to learn that it was the Rio Grande del Norte. He built a substantial fort on the Conejos River; but with the decline of fur trading about 1840 this and other forts lost significance and were replaced by government posts to protect settlers from the Ute Indians. The first fort, called Fort Massachusetts (1852), was soon replaced by Fort Garland (1858), whose ruined adobe walls are in plain view to the present-day tourists who cross the mountains over La Veta Pass.

The surrounding mountains, especially the San Juans to the west,

[2] *Ibid.*, p. 53.

attracted gold seekers after the Colorado Gold Rush of 1858. Until that time the San Luis Valley was a nearly unknown region despite its several hundred inhabitants and despite also the published reports of explorers and the writings of travelers. As a transit region to mining camps beyond, the valley became increasingly familiar, but the stage of permanent settlement was slow to follow.

A Desert Reclaimed by Middle Westerners

Only sixty years ago the first settlers from the Middle West arrived in the vicinity of Monte Vista which, with its annual rainfall of a little over seven inches, is quite the driest part of Colorado. For the most part the country was barren, quite unlike the landscape of the prairie states. In place of deep black loam, nearly everywhere the soil was sandy, liberally sprinkled with rounded stones. To be sure there were low bushes, but these by their gnarled and stunted growth seemed to bespeak a harsh struggle for existence and thus added to, rather than detracted from, the general desolateness. It was a desert (Fig. 2).

On the other hand, there were facilities for irrigation: a light fertile soil and the slight but uniform slope of the large alluvial fan constructed by the Rio Grande, which carried ample supplies for watering. On these are based the present community with its population of three thousand and a valuation of two million dollars. Its development has not been altogether easy: for the injection of a Middle Western culture here meant temporary sacrifices on the part of people many of whom are now living; it meant the development of new institutions; and it meant many mistakes, the effects of the most glaring of which are still plainly to be seen.

To the casual eye the site of Monte Vista is chiefly notable for its physical uniformity. However, the nearness of the alluvial fan to the mountains on the western edge of the valley, together with varying combinations of slope, drainage, soil types, depth of ground water, alkali and natural vegetation, largely altered by man, have modified the cultural landscape by differentiating four geographic types. These are the Rio Grande Bottoms, the Vegas, the Seep Lands, and the High Lands.

The Rio Grande Bottoms

The Rio Grande Bottoms (Fig. 3) suffer by comparison with other reclaimed portions of the Monte Vista region. The grass-large-tree vegetation scantily clothes the sandy-loam-to-gravelly soils. The surface is broken into isolated flats by the braided channels of the river, rendering the land incapable of close utilization and adding so much to the cost of bridge building that few north-south roads cross the river.

FIG. 2

FIG. 3

FIG. 4

FIG. 2—The untouched landscape of the western San Luis Valley. In the distance are the Conejos Mountains.

FIG. 3—A log house in the Rio Grande Bottoms, which still retains some features of pioneer life.

FIG. 4—The Vegas, natural grasslands of the Monte Vista region.

FIG. 5

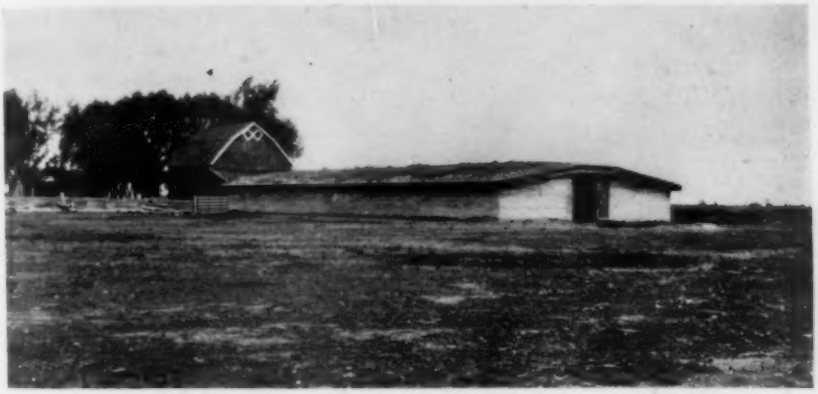

FIG. 6

FIG. 7

FIG. 5—House on the Seep Lands abandoned because of inundation.
FIG. 6—A potato "cellar," built aboveground for dryness.
FIG. 7—A typical farmhouse in the High Lands, north of Monte Vista.

OF MICH.

The bottom lands, largely nonirrigated though closest to the main source of water, retain not a few features of pioneer life. Many families live in log houses (Fig. 3), and farm equipment and buildings generally show evidences of disrepair. Many attractions to early settlement later impeded continued progress. In the bottom lands, for instance, short ditches of small volume sufficed for irrigation. Seepage rendered the surface soil moister than that of the higher lands, an aid to irrigation and also the fundamental reason for the grove-like vegetation which was the more attractive because of the barrenness of the surroundings. There was less surface accumulation of alkali here than elsewhere; and the sandy soil, which was well worked over through its close association with the graded Rio Grande, could be tilled with relative ease.

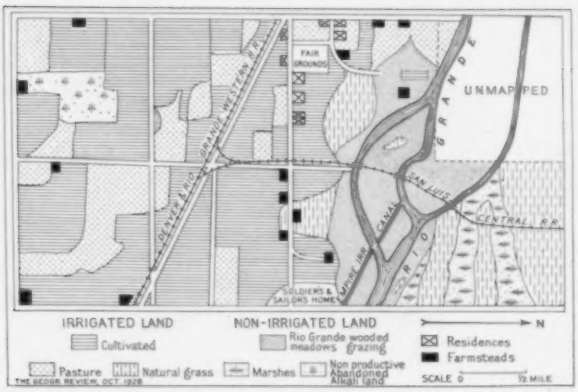

FIG. 8—Land utilization one mile east of Monte Vista in the Rio Grande Bottoms.

The present use of the lands near the river (Fig. 8) is typical of the Monte Vista region as a whole in which seventy-five per cent of the land is used in some connection with animal industries. That this stage of culture still persists is due to the close relation of dry plain to humid mountains and to the limited number of crops adjusted to the growing season of one hundred and ten days. Fruits are excluded by the brief spread between killing frosts and by low nocturnal temperatures induced by air drainage.

Thus in the Bottoms cattle range over the scant nonirrigated grasses or feed upon irrigated native pastures. Elsewhere irrigated native grasses and alfalfa are cut for hay, while patches of barley and oats provide additional winter food in this cornless region. Farther from the river potatoes and wheat are raised. Floods, which occur about once in six years, are a hazard; and the consequent destruction to live stock, crops, soils, and buildings is a still further present-day handicap of the Bottoms. The control of the flood waters of the Rio Grande is a step that should be taken immediately, since it will not only put economic activities on a still more permanent basis but will allow further land reclamation and will protect drinking water from contamination farther down the fan slope where the ground water movement is slow.

The Vegas

The Vegas (Figs. 4 and 9) are characterized by broad sweeps of open grasslands along Rock Creek, one of the few tributaries of the Rio Grande to resist absorption by the thirsty sands and gravels of the upper fan. These lands were settled at an early date because, again, irrigation was here a relatively simple matter.

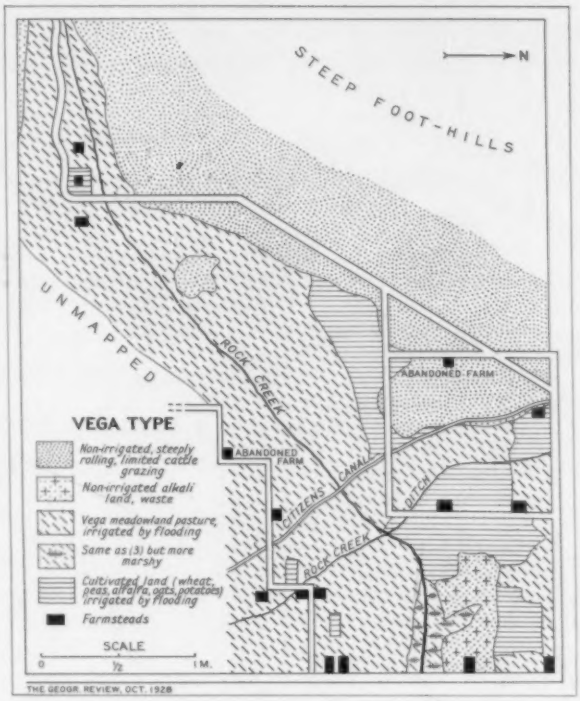

FIG. 9—Land utilization in the Vegas.

The use of flood irrigation is determined by two local conditions: the nearness of the water table to the surface, and the nature of the soil, a dense, sticky, plastic, black loam about two feet in depth underlain by sands and gravels interstratified with clay beds to indefinite depths. The condition of underdrainage, to which flood irrigation is in large measure a response, results from the position of the clay beds which do not maintain so steep a slope as does the surface of the fan. The successive truncation of water-bearing strata has made alkali an imminent danger; the water brought to the surface and evaporated leaves behind the salts gathered from the higher portions of the fan. Flood irrigation is a corrective of this condition since, by carrying the mineral load back to the "sub" (to use a local term) with which it drains farther down the slope, it reverses the process of alkali accumulation. The dense character of the deep Rio Grande loam also prohibits subirrigation.

The Vega farm is principally a wintering place for live stock. Closeness to the Rio Grande National Forest in the San Juan Mountains has made it possible for the farmer to maintain more cattle and sheep than the hay reaped from his three or four hundred acres of land will provide for. In early summer the larger proportion of the stock is driven or taken by stock train to high mountain pastures

and then in September is driven to the old mining town of Creede where a portion is sold to stock traders.

The Seep Lands

The Seep Lands, next to be settled, lie several miles to the east of the town. Before reclamation they were typical of by far the greater portion of the western San Luis Valley. The flat surface, sloping imperceptibly to the east and locally broken by small mounds

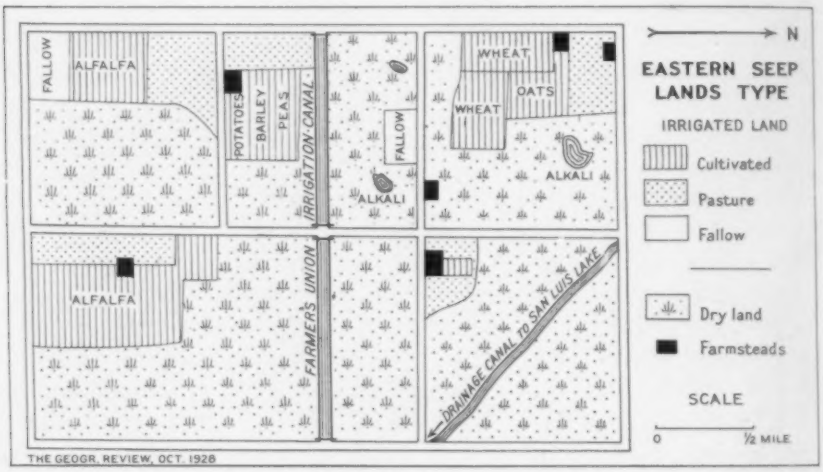

FIG. 10—Land utilization in the eastern Seep Lands.

of wind-blown sand, is scantily clad with bunches of chico bush, spreading, woody brushes which rise hip-high between the twisting paths of dry and crusty earth. The soil itself, a light sandy loam, is liberally sprinkled with rounded stones.

These lands, high above the Rio Grande and stretching miles from it, defied close utilization during the pioneer stage of development; but by 1880 the construction of large canals for irrigation was begun. The vast Rio Grande Canal with headgates at Del Norte, appropriating nearly a thousand cubic feet of water, was followed by the Citizens' Ditch, the Empire Canal, the San Luis, the Prairie Canal, and the Farmers' Union, making a total appropriation of over two thousand cubic feet.

Something like a boom followed in the parts of the fan watered by these canals, about twenty miles from the mountains where the soil was relatively free of stones. Wheat was raised almost exclusively. Phenomenal yields were reported and substantiated. Rapid reclamation of land from the desert was stimulated by the canal companies, together with homestead and desert entry.

Another variety of irrigation, called here subirrigation, was de-

veloped as a result of the greater depth of the ground water and the shortage of labor. An excessive amount of water is required to perform subirrigation; that is for raising the "sub," which may be twenty-five feet below the surface, to the level of plant roots. In order thus to make the water level conform to the slope of the surface for great distances much additional water is introduced to the subterranean drainage. This water working down the slope appeared at the surface in the lower parts of the fan, a condition which was hailed with joy for several years because such moistened land grew crops without irrigation.

The excess water, however, brought with it two results which swiftly changed joy to consternation (Fig. 5). Waterlogging of the soil was followed by increased alkali accumulation through its concentration in the Seep Lands from all the fields above. In the elevated places the soil became encrusted with salt, while in the hollows briny flats formed.

Abandonment and partial abandonment took place. The present stage in the economy of the Seep Lands is one of correcting the mistakes of the past by the institution of drainage districts and the practice of flood irrigation. Already in some of the affected areas covered wooden drains lead the water to open ditches, which return it to the Rio Grande to be used for irrigation. One of the most recent drainage districts is designed to lead the surplus water to the San Luis Lake, a natural sump in the eastern part of the valley. In the summer of 1927 this open drainage canal was in process of dredging.

Although much of the land is still in use, the larger part, formerly the cream of agricultural land in this region, has so completely returned to its natural state of plains grassland that the only evidences of its former utilization are the ruins of buildings, here and there an artesian well, and the dry ditches over which one occasionally stumbles.

The High Lands

Land utilization has reached its highest levels in the fan slopes to the north of Monte Vista. Here is produced the greater part of the surplus crops of the region; here land values and rents are at the highest figure, the best farm equipment is used, and a high standard of living is maintained. Indeed, it is in this part of the reclaimed desert that the rural Middle West is most nearly reproduced.

Farms a full section in size are not uncommon, the average being nearly four hundred acres. The management of such a large unit area is made possible by subirrigation in the cultivation of peas, potatoes, alfalfa, barley, oats, and wheat. Considerable grassland is also watered for pasture, but the High Land utilization is chiefly one of cultivation and represents the more recent developments in the region.

The potato, distinctly the cash crop of the High Lands, adjusts itself to the limited growing season and to the relatively cool nights, develops well in the light soil under the artificial control of water, and is remarkably free from pests. In the irrigation of the potato as well as of other crops, conditions are normally aided by a maximum spring and early summer rainfall, exactly half of the year's moisture falling from May to August. The timely spring rains make plowing a less difficult task and also raise the "sub" so that less ditch water is required for this purpose. It is in the occasional year when spring rains are few that great drains are made on the Rio Grande. If in addition the preceding winter has brought light snow in the mountains, ditches with late rights run low early in the season and those with water to sell reap large rewards. This combination of circumstances may be expected once in a dozen years.

The sorting and bagging of the potatoes, which necessitates hand labor—partly as a result of the many stones about the size of potatoes—is performed by Mexican families which drive into the region in covered wagons from Old and New Mexico and disappear in an equally unheralded fashion when the harvest is over. The production of about seven thousand carloads of potatoes yearly has so severely taxed the limited transportation facilities available that a large portion of the crop must be stored during the cold months. This difficulty has been met by the potato cellar, called such even though it is built above ground to avoid moisture. The three-foot adobe walls and sod roof are quite perfectly adjusted to the absolute winter night temperature of $-30°$ F.

Field peas, which constitute a larger percentage of the cultivated crops than do the potatoes, are used to finish lambs for market and are thus a response to sheep-herding in the mountains and to the short growing season. In the autumn, lambs bought at Creede are corralled in the pea fields to harvest the crop and fertilize the ground for another season and at the same time increase the value of the meat. Hogs are also prepared for market in this way.

Monte Vista, the Trade Center

Today the town of Monte Vista has the prosaic appearance of a trading community. Its functional capacity is clearly shown in urban land specialization, with especial emphasis upon the type of activity in the limited manufactural area, the character of the relatively large commercial district, and the imperceptible merging of town and rural land utilization.

Of the two manufactural activities of Monte Vista the milling of spring wheat, brought from the surrounding country in motor trucks and by rail from even as far as the San Juan Basin, is by far the more

important. Largely an adjustment to remoteness, it typifies the region in that the majority of the daily output of two hundred bags of flour is marketed outside the San Luis Valley.

Exposure of the seven-thousand-foot-high piedmont plain to strong diurnal winds which have whipped its eastward-sloping sandy surface into pits and mounds has induced the manufacture of grading

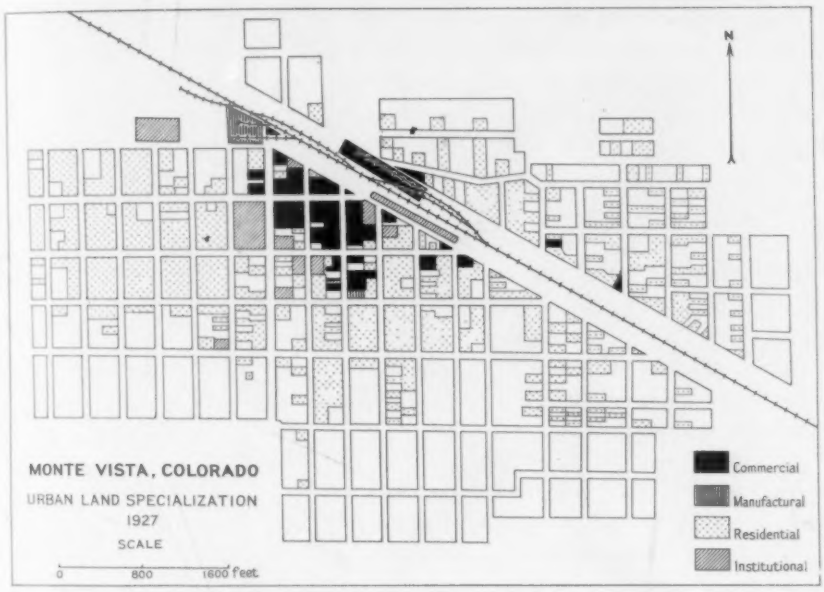

FIG. 11—Land utilization map of the town of Monte Vista.

machines in Monte Vista. These implements, called "fresnos," aid in restoring the smooth surface of the plain preparatory to its irrigation.

Worthy of note in the commercial area are: a section called "Potato Row," comprising the offices of dealers in potatoes and burlap bags, whose ranks are augmented in October and November by about thirty-five additional buyers; two potato warehouses near the tracks of the Denver and Rio Grande Western Railroad, two coal yards which distribute fuel received from three distant coal fields in Colorado (Walsenburg, San Juan Basin, and Crested Butte); offices of irrigation companies and of civil engineers at present largely engaged in drainage problems; and various other businesses from traders in sheep and wool and other live stock, dealers in fur and hides, and assemblers of agricultural implements, to those of local interest, the greater part of whose trade is derived from a twenty-mile radius of the town. In the summer season there is further activity arising from the tourist travel directed toward the San Juan Mountains and Mesa Verde National Park.

Nature, so niggardly with surface water, seeks to compensate with a bountiful underground supply so that artesian wells take the place of municipal waterworks.[3] A well is drilled to a depth of about one hundred feet, bringing the water to a sufficient height above the ground to run a hydraulic ram which, in turn, forces water into and through the house. At the present time the water is allowed to run continuously, and that which is not used either aids in the irrigation of the garden with which nearly every home is provided or flows into one of the irrigation ditches which thread the town. This water, maintaining a constant low temperature in summer as well as in winter, has reduced the demand for ice to a low point. Fire protection is provided by deep-dug wells at frequent intervals; the water draining into them is forced by pumps to a sufficient height to protect the low buildings of the town.

The mask of sameness that characterizes the American town is broken here in certain particulars. Areas with poor drainage resulting from a high water table, especially to be avoided here because of the consequent alkali accumulations, have been relegated to inferior uses. This is notably the case in the Lariat subdivision, a region of Mexican dwellings made of local adobe soil, squat and picturesque but comfortless.

On the numerous country roads crossing the featureless plain along section lines, the chief expense of grading has been the necessity of crowning above the limit of ground water. The typical road of this locality, long and straight and lined on either side by deep ditches containing stagnant drainage water, stretches endlessly before one. In winter there is no snow to handicap road travel, the small amount that falls soon evaporating or melting where exposed to the bright sun. Favorable conditions of winter travel have made the consolidated school more than ordinarily feasible here. The selection of Monte Vista as a site for one of the four schools of Rio Grande County has resulted in prominently identifying the town as the educational center of its locality as well as its economic focal point. This has measurably aided in furthering the unity of the Monte Vista region.

[3] See C. E. Siebenthal: Geology and Water Resources of the San Luis Valley, Colorado, *U. S. Geol. Survey Water-Supply Paper 240*, Washington, 1910.

THE GEOGRAPHICAL RELATION OF SOIL EROSION TO LAND PRODUCTIVITY

Hugh Hammond Bennett

U. S. Bureau of Chemistry and Soils

SOIL erosion is the greatest single menace confronting the physical side of land utilization in this country.[1] That we have had at our disposal tremendous areas of fine agricultural lands and have employed these for the production of enormous crops, and shall continue so to employ them for a long time to come, does not alter the situation or make it any less menacing, regardless of the soothing complacency found in the annual outturn of our expansive fields. The nation is not at the moment suffering from any land shortage, and we are not on the verge of starving as the result of wholesale wastage of soil productivity by unrestrained erosion.

Nevertheless, the problem is an exceedingly serious one and will surely become increasingly so under the prevailing inactive attitude of most farmers in relation toward it, that is to say, of doing little or nothing to check it and much to accentuate its evil effects. Already thousands of farmers have moved to town or to other farms because of the impoverishing effect of soil erosion, and a very large total area of land has been abandoned, in so far as cultivation is concerned. Little of the abandonment took place before the topsoil had been washed off or the fields riddled with gullies. The area thus abandoned is being increased every year and probably at a much faster rate than soil recuperation is taking place in the older abandoned areas now covered or partly covered with vegetation. The writer ventures the opinion that between 40 and 50 per cent of the land now in tilled crops in this country has suffered in some degree from soil erosion and that about one-fourth of this has suffered seriously, that is to the extent either of materially reduced yields or of requiring markedly increased soil management efficiency to maintain the yields.

Plant-Food Wastage: Some Pertinent Estimates

With the information available, meager as it is, it is yet possible to make rough minimum estimates of erosional wastage. If we use as a basis of calculation 500 million tons of the 513 million tons of suspended matter annually transported to tidewater by the rivers of the United

[1] See also H. H. Bennett and W. R. Chapline: Soil Erosion a National Menace, *U. S. Dept. of Agric. Circular No. 33*, Washington, 1928.

States,[2] together with twice this amount of material removed from fields and pastures but stranded en route to the sea, it is found that at least 126 billion pounds of available and potential plant food, as well as the soil containing the plant food, are taken out of the fields and

FIG. 1—This former excellent farm land in Georgia (Greenville sandy loam type) has been permanently destroyed by gullying, as the result of a wash which had its beginning from the drip off the eaves of a barn. (Photograph by Division of Agricultural Engineering, Bureau of Public Roads.)

pastures of the nation every year. This figure is based upon the average chemical composition of 89 samples of surface soils collected throughout the country. That it is a minimum calculation is obvious to those familiar with field conditions. There is no doubt whatever that the amount of soil material annually stranded upon lower slopes, over

[2] As estimated by R. B. Dole and H. Stabler: Denudation, *U. S. Geol. Survey Water-Supply Paper 234*, Washington, 1909, pp. 78–93.

stream flood plains, and in reservoirs and stream channels is vastly greater than the amount that actually enters the oceans every year; probably it exceeds that going into the sea by more than a hundred times. Furthermore, the estimate given above does not include the

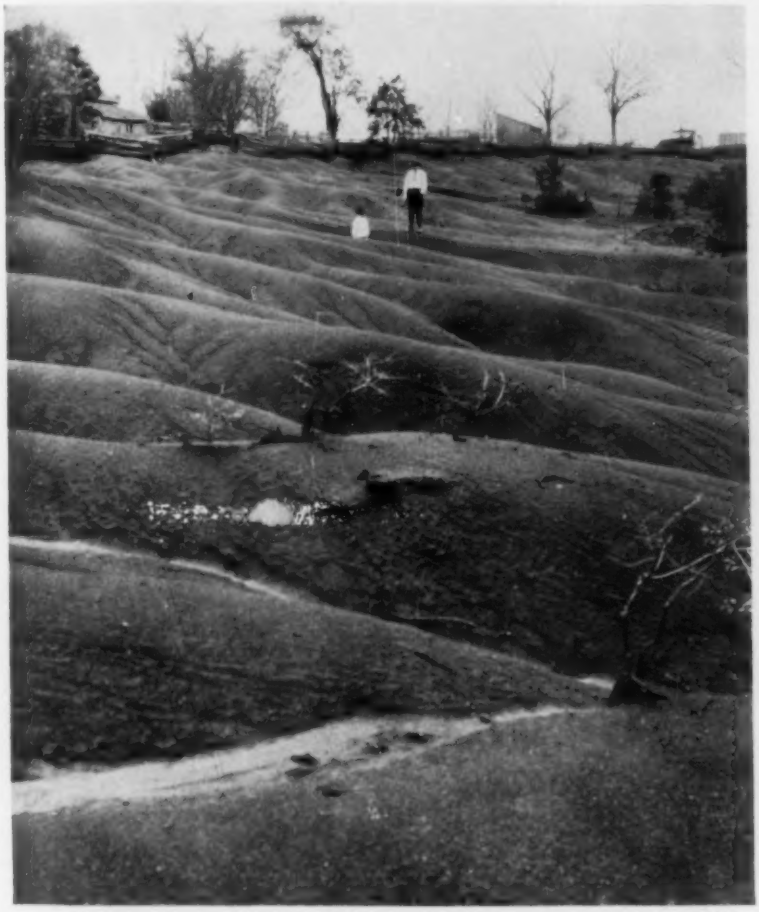

FIG. 2—This land should never have been plowed. The soil, originally Susquehanna fine sandy loam, washes excessively on steep slopes. Here the former subsoil is now the soil and is valueless.

270 million tons of dissolved matter annually lost to tidewater, much of which comes from the soil. Nor does it include the drag material, the coarser particles, swept along the bottoms of the rivers. Again, there is reason to believe the determinations of the amount of material carried in suspension are too small, since they are based upon measurements of the surface water, not deeper than two feet, in the case of the Mississippi River, which carries by far the greater part of the material going out to sea.

Even the plant food contained in this minimum of material exceeds the annual net loss of plant food in the crops removed by twenty-one times.[3] Crops remove only the plant food, which can be restored; whereas erosion removes not only the plant food but the whole soil, which cannot be restored.

Since the greater part of the wastage is the work of sheet erosion, the bulk of the material comes from the surface soil, the most productive part of the land. In terms of money value for the estimated amount of material removed it is impossible to reach any very definite conclusion, since a variety of pertinent complications, chiefly bad ones, follow in the wake of erosion. When the mellow topsoil is gone, stiffer and less productive subsoil material generally takes its place, that is, where still more unfavorable gravel, sand, and loose rotten rock are not exposed; and this is more difficult to till, although needing more efficient tillage. In dry times when it is most needed by crops it is less absorptive of moisture and less retentive of that which is absorbed; and the contained plant nutrients are not so readily available. This necessitates more liberal use of fertilizers, manure or soil-improving crops, and often lime. The farmer must deal with all of these obstacles in order to maintain his acre yields, or else abandon the land to grass and trees or, as more frequently happens, to useless brush and weeds.

FIG. 3—Soil impairment by erosion, Granitic Piedmont, Orange County, Virginia. 1, only slightly eroded: good Cecil fine sandy loam, with eight or ten inches of soil; 2, washed until only two to five inches of soil is left: poor, eroded Cecil fine sandy loam; 3, all soil washed off down to clay subsoil; numerous gullies; useful for trees only; 4, both soil and subsoil largely washed off to rock: mainly useless land; 5, stream alluvium formed of local erosional débris: forest and meadow land. (Surveyed by B. H. Hendrickson, Bureau of Chemistry and Soils, 1927.)

[3] Annual net loss of plant food for the United States by crops removed has been estimated at 2,900,000 tons (The Condition of Agriculture in the United States and Measures for Its Improvement: A Report by the Business Men's Commission on Agriculture, published jointly by the National Industrial Conference Board and the Chamber of Commerce of the United States, Washington, 1927, p. 106).

Calculating the value of the phosphorus, potash, and nitrogen contained in the material stripped from the fields by erosion, in the minimum estimate given above, on the basis of the cheapest commercial fertilizer that carries these nutrients, we arrive at a money valuation of approximately two billion dollars. For obvious reasons not all of this can be charged up as a direct tangible loss to the farmers of the nation; but there is evidence that about two hundred million dollars of it is a yearly tangible loss.

Probably not less than ten million acres of land formerly cultivated in this country have been permanently ruined by soil erosion, in so far as having value for cultivation, and an additional three million acres of good stream alluvium have been rendered valueless or have been severely impaired as a result of overwash of comparatively inert sand and gravel and increased swampiness due to choked stream channels. Half or more of the former productive bottom lands along the streams of the southern Piedmont have been made unfit for cultivation, and countless strips of alluvial soil through the Ozarks region have been buried with gravel on farms, where, in many instances, most of the arable land was that along the streams.

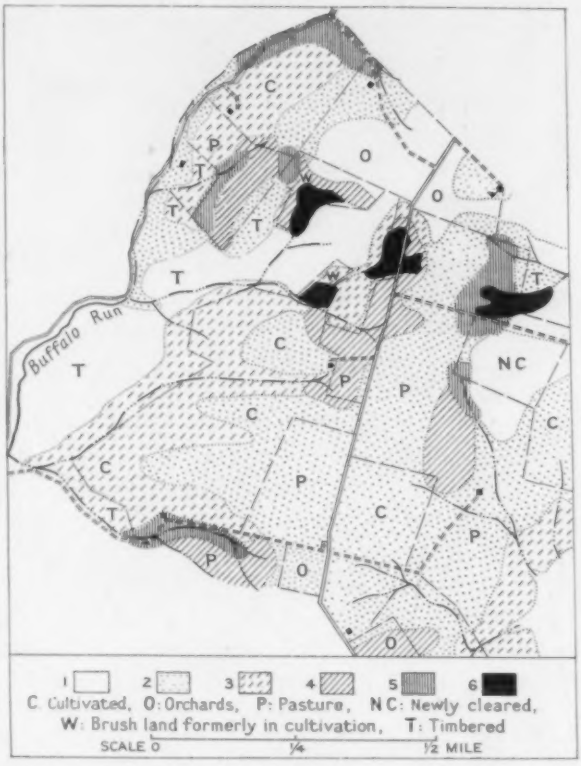

FIG. 4—Soil impairment by sheet erosion on comparatively smooth Appalachian Plateau, Hampshire County, West Virginia. Numbers have reference to amount of topsoil removed: 1, uneroded or only slightly eroded; 2, 20 to 30 per cent removed; 3, 30 to 40 per cent; 4, 40 to 50 per cent; 5, 50 to 75 per cent; 6, all topsoil removed. (Surveyed by B. H. Williams, Bureau of Chemistry and Soils, 1927.)

But this kind of land destruction and impairment represents but a small part of the damage done. The great wastage has been that which has effected partial or complete removal of the more productive surface soil by the less spectacular phase of erosion known as sheet erosion.

The damage that has been done and continues to be done by this process cannot be calculated. The worst aspect of the situation is that since the less absorptive subsoil layers are more erosive than was the more absorptive soil layer, now gone and going over immense areas, we really stand upon the threshold of unthinkable erosional wastage, if present practices continue.

Lack of Quantitative Data

The qualitative aspect of the soil erosion problem is obvious enough and has frequently been discussed,[4] but it is rather disheartening that at this stage of our development we have accumulated in this country what amounts to almost nothing in the way of the quantitative data necessary for its intelligent solution. Only three stations for studying the problem have thus far been established, and these only recently. They are located at Spur in western Texas, at Columbia, Mo., and in the Piedmont region near Raleigh, N. C.

The problem of soil erosion is complex, for the process is exceedingly variable in its effectiveness from place to place, on varying soil and slope, with varying vegetative cover, type of land usage, and character of precipitation. The average depths of surface denudation that have been computed from river discharges alone mean very little. They imply that the surface everywhere, on steep hillsides and flat prairies, on sand dunes and loam and clay and silt, is being planed down at an equal rate. The statement we so often read that the surface of the vast Mississippi Basin is being lowered by erosion at the almost insignificant rate of .0028 of an inch annually is not only too small as an average but, since erosion does not operate according to any fixed plan of averages, is meaningless and dangerous for its complacency. In this paper illustrations will be given of the process at work under varying conditions, these illustrations being largely taken from the writer's own field work.

Some Measurements in the Field

At Spur, Tex., 40 tons of soil material were removed from one acre of bare land, with a two per cent slope, by 27 inches of rain. From one acre, with nine per cent slope, in the Piedmont of North Carolina, 25 tons were removed by 36 inches of rainfall. On another soil of approximately four per cent slope in central Missouri, the Shelby loam,[5] 41 tons were lost per acre per year, with 36 inches of rain, on bare ground tilled four inches deep.

From grassland in North Carolina, the rate of erosion was 415 times

[4] For a recent statement see W. C. Lowdermilk and J. Russell Smith: Notes on the Problem of Field Erosion, *Geogr. Rev.*, Vol. 17, 1927, pp. 226–235.

[5] For description of the Shelby soils, and other soil types subsequently referred to, see H. H. Bennett: The Soils and Agriculture of the Southern States, New York, 1921.

FIG. 5

FIG. 6

FIG. 5—Effect of a single rain upon a gently sloping area of rich Iowa loam.

FIG. 6—Complete destruction of fine silt loam soil in the loessial region of Mississippi. The clay subsoil exposed in this view is unsuitable for the growth of anything.

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slower than on bare ground of the same slope and soil; while at the Missouri station the rate of wash-off from sod land was 137 times slower than from bare ground plowed four inches deep. In the latter instance the rate of wearage for bare ground was seven inches in 24 years, and for blue-grass sod seven inches in 3547 years. Grass proves not only highly efficient in restraining soil erosion but also in conserving rain water. In Texas grassland held back 82 per cent of the rainfall, at least temporarily; whereas only 55 per cent was retained in cotton fields. In Missouri grass retained 88 per cent of the rains, and shallow-tilled, bare ground only 69 per cent; in North Carolina grass caused 98.5 per cent of the precipitation to remain on the land, whereas only 65 per cent of it remained on bare ground.

Such data are indicative of what has been taking place on the sloping areas of the Mississippi Basin since the breaking of the vast mat of sod that originally covered the prairies of that region. They are suggestive also of the powerful restraint exerted by forests upon the wash-off and run-off; for much of the land concerned was originally timbered, and trees, like grass, hold back both soil and water.

If grass sod in the Piedmont enables an important agricultural type of that region to hold back 51 per cent more of the rainfall than bare ground, and 33 per cent more than fields planted to cotton, what saving are we to expect from a well-forested area with a good ground cover of woods mold consisting essentially of peat, knowing that some forms of peat are capable of holding water in excess of a hundred times their own weight? That we do not have an abundance of measured data of this nature for our key soil types, proves the pressing necessity for research in this field.

Factors Affecting Soil Erosion

Soil erosion[6] has been going on undoubtedly since the first rain that followed the development of the first film of soil. We are not especially concerned here about natural or normal erosion, since it is largely unpreventable[7] and, as a rule, does no great damage to the land. It is abnormal erosion that we are concerned with: that excessive washing of the soil which is due to removal or impairment of the vegetative cover and to physical disturbances of the ground, as a result of land clearing, grazing, fires, plowing, ditching, etc., most of which is the direct or indirect result of man's activities, chiefly his unwise methods of using the land.

[6] This paper is concerned with water erosion. Wind erosion functions in a manner quite similar to water erosion and does a vast amount of damage. It is a major phase of erosion, however, and will be treated in another paper.

[7] It should be noted however that there are some exceptions to this statement. It might be possible, for example, to find some shrub or vine or grass that would thrive on such wasting areas as the Bad Lands, bind the soil, and keep large quantities of silt out of the streams. And it is quite possible to check erosion along the sea coast in places.

Over large areas normal erosion proceeds at a rate that about equals the formation of soil from the rock and other parent materials. On the other hand, abnormal erosion, which we here refer to simply as *soil erosion*, usually exceeds the rate of soil formation on sloping areas, although varying in its progress with: (1) soil character, (2) character of vegetative cover, (3) degree of artificial ground modification, (4) degree of slope, and (5) climate. This order of arrangement has little to do with the relative importance of these most important erosional variants, except that soil character probably should head the list.

Climate is a very important erosional factor, as a matter of course. Hard beating rains of summer are much more destructive than the slowly-falling showers that characterize some regions. When the ground is frozen deeply or covered with a blanket of snow for long periods there can be no erosion until thawing starts the water downhill; and this, as a rule, will be a gradual process, less destructive than heavy rains. Probably the loosening effect of alternate freezing and thawing upon some soils gives a condition of porosity that makes them more resistant to erosion than similar soils of warmer latitudes. Spew frost, by lifting films of soil, effects considerable local downward movement of material on steep slopes of certain soils, when the small columns of supporting ice melt.

Most of these climatic effects are modified by soil types, usually very greatly. One of the most important points about the relation of climate to erosion is that there is erosion wherever there is enough rainfall for water to run downhill. There are some peculiar soils that absorb most of the rainfall, even clay types, no matter how heavy the precipitation; but even on these the open pore space is sometimes temporarily filled, and some of the rainfall does flow away and accomplish a small amount of surface wastage. The least erosion ever observed by the writer, the one place where there was no appreciable washing, was on a soil type that belongs to a class of highly erosive soils, that is wind-blown silt loam. In this instance, encountered on the slopes of the Tanana River below Fairbanks in northern Alaska, one and three-fourths degrees south of the Arctic Circle, the resistance to erosion is entirely climatic. The rainfall is exceedingly light, about 11.5 inches, and it falls as light showers. The soil is frozen eight or nine months, and the region has a sub-ice cap, that is, the ground is permanently congealed from depths of a few feet below the surface down to bed rock.

Indirectly, climate is closely related to soil erosion. Under certain climatic conditions, as those characterizing the humid tropics, highly percolative clays which are very nearly nonerosive,[8] have been

[8] H. H. Bennett: Some Comparisons of the Properties of Humid-Tropical and Humid-Temperate American Soils, *Soil Science*, Vol. 21, 1926, pp. 349–374; H. H. Bennett and R. V. Allison: The Soils of Cuba, Tropical Plant Research Foundation, Washington, 1928.

formed under forest cover. Again, in the dry regions soils have been formed which are tremendously susceptible to erosion because of peculiar structural conditions associated with high contents of the soluble bases.

Dole and Stabler's figures for river silt in suspension[9] reveal striking correlations between erosion, on the one hand, and soil and

FIG. 7—Soil "mining" in the loessial region. These corn rows running up and down the hillside have well-started gullies between them. (Photograph by W. R. Mattoon, U. S. Forest Service.)

climate, on the other. For example, the amount of material carried in suspension by the Missouri River near its confluence with the Mississippi is 1138 parts per million; whereas the average content for three rivers of the northeastern United States, the Kennebec, Housatonic, and Hudson, is only 8.3 parts per million. The Rio Grande at El Paso carries 14,140 parts per million. The Missouri flows through a region including much highly erosive silt soil (loessial soils); the Rio Grande traverses dry country where much of the soil upon desiccation breaks down into a fluffy structure favoring rapid removal by rainwash; whereas the group of northeastern streams receive their drainage from an area largely comprising absorptive glacial till soils that are but slightly inclined to wash. The Rio Grande carries 700 parts of dissolved matter per million; the Missouri, 294 parts, and the northeastern stream group only 77.5 parts.

[9] Paper cited in footnote 2.

Variations in Clay Soils

Reference has already been made to the case of a two per cent slope of clay loam (Abilene) in subhumid western Texas, which showed an erosional loss of 40 tons of soil per acre with 27 inches of rainfall;

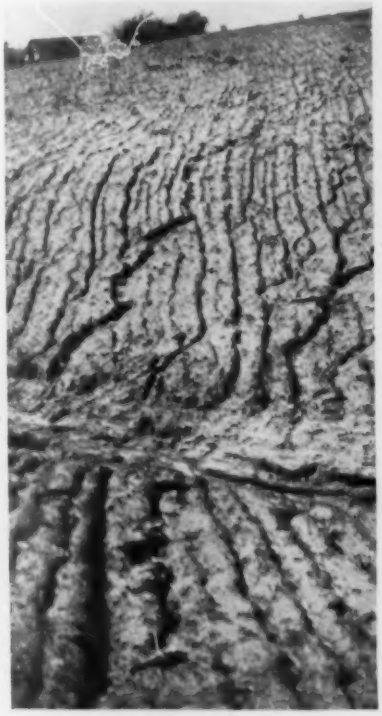

Fig. 8

Fig. 9

Fig. 8—A field in northeastern Kansas (about twelve miles from the Missouri River) that was riddled by erosion during a single rainy spell in the fall of 1927. Some 40 tons per acre of the richest topsoil was then lost.

Fig. 9—By a peculiar soil-scaling process upon drying, the face of this gully of deep silty clay in southwest Texas has cut through into the next gully abnormally quickly.

whereas sandy clay loam (Cecil) in the Piedmont of North Carolina showed a loss of only 25 tons per acre from a nine per cent slope, with a precipitation of 36 inches. Considering the fact that the carrying capacity of water increases enormously with the velocity, as does also the scouring capacity, the results obtained at the Piedmont station stand out as a remarkable example of the influence of soil upon the rate of erosion. Even so, the Piedmont soils suffer greatly from rain-wash on all unprotected slopes. But for the fact that a large proportion of the soils of this region contain much highly weathered clay of a peculiar porous character, functioning as erosion-resistant material, this part of the country doubtless would have been largely washed down

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to its bed rock long ago, as has happened in many rolling Piedmont areas of the plastic Iredell soils.

Clay land having powerful resistance to erosion is very extensive in the humid forested areas of northern California and in western Oregon and Washington, such as the Aiken clay and clay loam.[10] These lands are used on steep slopes for prunes and other fruits with very little evidence of washing, even where cultivation is carried up and down the slopes, rather than along the contours. These are tropic-like soils of low silica and high iron and alumina contents, much like those of eastern and middle Cuba.[11] As a result of recent studies within tropical regions of the western hemisphere it has been learned that certain extensive types of highly weathered clays, those having low ratios of silica to iron and alumina (a molecular ratio of less than two) are practically immune to erosion.[12]

The less weathered clays, whose products have not been highly oxidized or severely leached since the disintegration of the parent materials, show opposite properties, with respect to erosivity, to the tropic-like or highly-weathered clays. These types have relatively high contents of silica and low contents of iron and alumina (a molecular ratio greater than two).

Such impervious, plastic clays are characteristically exemplified in the extensive yellow clay soils of the Iredell series of the southern Piedmont, a derivative of basic igneous rocks; the very extensive Susquehanna soils, having mottled clay subsoils, derived from plastic clays of the Gulf Plain area, extending from west-central Georgia to central Texas; and the Lowell and Fairmont soils of the limestone areas of northern Alabama, central Tennessee, Kentucky, and southern Ohio and Indiana. In a single county of the Piedmont, 90,000 acres of land, formerly cultivated, productive soil, have been largely destroyed by gullies. This was mapped by the Soil Survey as Rough gullied land,[13] that is largely non-arable land, with a considerable part washed off to bed rock. The general appearance of the area indicates that since the survey was made, seventeen years ago, several additional thousands of acres have attained this all but desert condition. Centuries of soil building will be required to restore the land to cultivation.

In one county of the coastal plain region 70,000 acres of land, most

[10] E. F. Torgerson, Charles Hartmann, Jr., E. J. Carpenter, and W. G. Harper: Soil Survey of Polk County, Oregon, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1922—Advance Sheets*, pp. 1681–1721.

[11] H. H. Bennett: Some Geographic Aspects of Cuban Soils, *Geogr. Rev.*, Vol. 18, 1928, pp. 62–82; reference on p. 80.

[12] Bennett and Allison, *op. cit.*, pp. 238–239; H. H. Bennett: Agriculture in Central America, *Annals Assn. of Amer. Geogrs.*, Vol. 16, 1926, pp. 63–84; *loc. cit.*: Some Comparisons of the Properties of Humid-Tropical and Humid-Temperate American Soils.

[13] M. E. Carr, F. S. Welsh, G. A. Crabb, R. T. Allen, and W. C. Byers: Soil Survey of Fairfield County, South Carolina, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1911* [*13th Rept.*] pp. 479–511.

of which was cultivated at one time, have been mapped as Rough gullied land and Susquehanna clay, now having very little or no crop value as the result of erosion.[14] Of this, 33,000 acres were classed under the latter designation and described as follows:

"The Susquehanna clay occupies steep slopes, the crests of rounded hills, and the tops of ridges. Erosion has so gullied the greater part of the type that there is practically no level land within its boundaries. . . .

"*The rough character of this land, which prohibits tillage operations over much of it, is the result mainly of erosion which has taken place since the land was cleared for cultivation.* [The italics are the author's.] The Susquehanna clay was one of the first soil types farmed in the county. It was considered strong land and produced as much as a bale of cotton per acre without the use of fertilizers. There are today on this type many deserted but substantial farmhouses, abandonment of which was compelled by the ruining of the fields by erosion."

Of the 37,000 acres of Rough gullied land the report says:

"Rough gullied land includes areas which, as the result of erosion, are so steep and broken as to be unfit for agriculture. . . . Some areas are available for pasture, but a considerable total area is not even suitable for this use, as there are many deep gullies with steep or perpendicular sides on which no vegetation can find a footing. Providence and Trotman "Caves," to the west and north of Lumpkin, are examples of such areas."

Until recently it had generally been supposed that all soils of high clay content were necessarily heavy, stiff, and impervious and that the sandy soils were friable and pervious. Recent studies have shown that this depends upon the kind of clay present, that is where any considerable amount of particles of clay diameter is present in the material. The low and high erosivities exhibited by the two varieties of clays discussed above are due, respectively, as well as can be determined from the accumulated evidence, to high and low degrees of flocculation[15] of the soil particles. Perhaps it would be more appropriate to define the physical condition in the latter instance as being due to a comparatively high degree of particle dispersion. At any rate the particles of these plastic clays, such as the Susquehanna and Iredell of the United States and the Bluefields[16] of eastern Nicaragua, are not flocculated soils as the term is generally understood. They are dense clays without free pore space through which water can move freely under force of gravity, and they shrink and swell violently at the extremes of moisture content. On the other hand, the group of clays having opposite characteristics have an abundance of pore space, through which water moves downward freely. Some of these clays are

[14] D. D. Long, M. W. Beck, E. C. Hall, and W. W. Burdette: Soil Survey of Stewart County, Georgia, *U. S. Dept. of Agric., Field Operations of the Bur. of Soils, 1913* [*15th Rept.*], pp. 545–606.

[15] Lack of flocculation corresponds to what soil technologists commonly speak of as dispersed soil. In this state the particles stand alone as individuals. Thus unsupported they are more open to attack than the particles of flocculated soils, with their grains bound together in clusters.

[16] J. C. Treadwell, C. R. Hill, and H. H. Bennett: Possibilities for Para Rubber Production in Northern Tropical America, *U. S. Dept. of Commerce Trade Promotion Ser. No. 40*, 1926, pp. 142–143.

FIG. 10

FIG. 11

FIG. 12

FIG. 10—This dike, protecting the highly productive Missouri River bottom land, has caught eight feet of erosional débris from the uplands in ten years. The rate of deposition of a forty-acre field here was 1200 tons per acre per year.

FIG. 11—Wheat straw dumped in a depression caught 430 tons of rich soil material washed from the adjacent slopes during fall rains (northwestern Kansas).

FIG. 12—These gravel-coated clay balls, found in a southwest Texas stream bed, illustrate a curious form in which land material is being transported to the sea.

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FIG. 13

FIG. 14

FIG. 15

FIG. 13—Excellent valley grazing land in the arid southwest being rapidly ruined by erosion which started in the bedding ground of cattle.

FIG. 14—Channel-trench erosion in the Trans-Pecos region, southwest of Valentine, Tex., 1927.

FIG. 15—This is a deep erosional gully in a formerly timbered area in northern California. The vegetative cover was largely annihilated by smelter fumes.

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almost as friable as sand and take up the rainfall just as readily. They also exhibit almost negligible properties of shrinking or swelling with decrease or increase of the moisture content.

Erosion of Silt Soils in the Mississippi and Missouri Basin

The upland silt soils of the United States, including some of the most important agricultural lands of the nation, are all erosive types, some representing probably the most erosive of all soils to be found in the country. Those that are most susceptible to destructive washing, both by sheet and gully erosion, are found in the great areas of loessial soil bordering the Mississippi River on the east side from the vicinity of Baton Rouge, La., across western Mississippi and Tennessee and southwestern Kentucky and bordering also the Missouri from its confluence with the Mississippi to the boundary of South Dakota. This great area includes some of the very best upland corn soils we have, such as the Marshall silt loam; also good corn, grain, and apple soils, as the Knox silt loam; and, in the southern part, good cotton lands, as the Memphis and Granada silt loams.

That these lands wash severely is due to three principal characteristics: (1) Lack of flocculation of the silt particles, coupled possibly with incoherency resulting from a low content of binding clay; (2) the presence in the substrata of a soft silt layer; and (3) the generally rolling topography, particularly of the Memphis and Knox soils. The wastage is by a three-step process, i.e. the silty surface layer is gradually removed from unprotected slopes by sheet erosion; then gullies cut through the normal silty clay subsoil into the soft silt layer beneath; whereupon devastating dissection begins, the gullies deepening and spreading very rapidly. In some parts of the southern extension of the region the major part of the uplands of a number of counties has been ruined by erosion, and, as a consequence, farming has been largely driven into the stream bottoms. Unfortunately, many parts of the stream bottoms have been covered with comparatively inert sand assorted from flood waters, and the channels of numerous streams have been so choked with erosional débris that overflows are much more common than formerly.

While the damage has not been quite so serious there has been a considerable degree of gullying in the Missouri River belt of loessial soils and an enormous amount of sheet erosion. In the fall of 1927 the writer found from one to two feet of rich, mellow silt loam over clay in areas of virgin timber in northeastern Kansas, where over adjacent areas having the same slope and soil, cleared about 40 years ago, all of the soil had been washed off in numerous abandoned and tilled fields. In some of these a half a foot or more of the subsoil had been removed after the soil had been carried away. Indeed, bed rock

was exposed in places, which originally was covered with four feet of soil material.

In some fields of the region having only moderate slope it was found that more than 40 tons of soil material per acre were removed from the Marshall and Knox silt loams as the result of a single rainy period that followed the seeding of the land to grain. The grain was mostly washed out, and the fields were riddled with miniature gullies (Fig. 8). Against a pile of wheat straw at the foot of two converging slopes 430 tons of soil material that had been washed down by the fall rains (1927) were lodged (Fig. 11).

Already in this region of exceptionally productive soils, gullied fields are being abandoned to pasture, and most of the sloping areas have been impoverished in some degree by soil wash, with many thousands of acres denuded of their productive topsoil. Apple trees are dying in a number of orchards as the result of erosion. Generally on the lower positions where some of the wash has temporarily stranded the apple trees and other crops are doing well, showing that the deterioration on the higher slopes is the result of soil removal. In one orchard the surface now stands five feet higher than the ground upon which the trees were planted.

On another farm in northeastern Kansas the operator had constructed an eight-foot dike to intercept outwash from the adjacent uplands, which was damaging his rich alluvial corn land in the Missouri River bottoms and covering his roadways. In ten years the land behind the dike had been filled in level with the dike over a 40-acre field (Fig. 10). In other words, deposition of erosional débris had taken place here at the rate of 1200 tons per acre per year.

This sort of thing is going on in many places in the bottoms of the Missouri and its tributaries. Nothing of any importance is being done in the region to slow down erosional wastage; whereas much is being done to accentuate it. Corn rows are often run up and down the slopes rather than along the contours, a practice that invariably speeds up the effects of rainwash. It is also a common practice to plow furrows down the slopes in springtime in order to drain water from between corn rows. Many of these relief furrows grow into gullies which, dividing, dissect the fields and eventually cause their abandonment to pasture or brush. Even then the washing continues for a considerable time.

An Erosion Type in the Central Coastal Plain

A number of other important types of farm land have suffered disastrously from dendritic gullying owing to the rapidity with which the incisions extend themselves when the coarser materials underlying the soils have been cut into. Some of these types, such as the valuable group of soils characterized by the Orangeburg and Greenville series

of the central coastal plain region, are so susceptible to this kind of wastage that it is safe to make the statement that not one acre of them should be used for the clean-cultivated crops without protection with terraces, whenever the slope exceeds four or five per cent. It was principally on these types that 37,000 acres of former cultivated land were found by actual survey to have been destroyed in Stewart County, Georgia, in 1913, as already noted. Probably not less than half a million acres of these excellent cotton and corn soils have been permanently destroyed or temporarily made unsuitable for profitable cultivation by soil erosion.

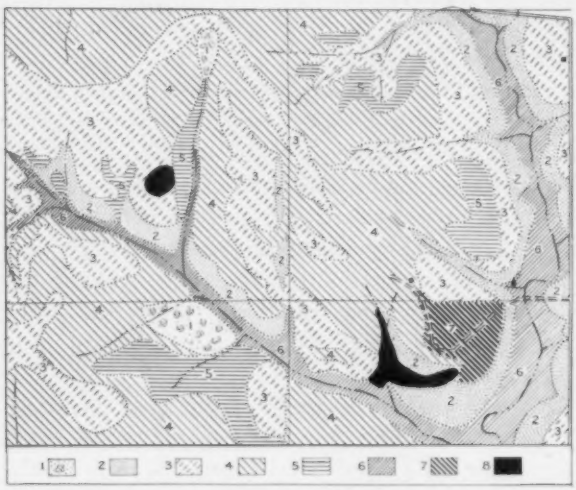

FIG. 16—Soil impairment by sheet erosion on Knox silt loam, Donipher County, Kansas. The area represented is 120 acres. 1, virgin timber: 12 to 24 inches of dark-brown mellow silt loam, over yellow silty clay loam, uneroded soil; 2, soil washed from higher slopes: 10 to 20 inches of brown silt loam over yellow silty clay loam of previously eroded areas; 3, cultivated fields: 4 to 10 inches of light-brown silt loam over yellow silty clay loam: 8 to 14 inches of topsoil washed off; 4, cultivated fields and orchards: 2 to 4 inches of yellowish-brown heavy silt loam to silty clay loam over yellow silty clay loam; 10 to 26 inches of soil washed off; 5, steeper cultivated slopes: light-brown, silty clay loam, i. e. exposed subsoil; 12 to 30 inches of soil washed off; 6, alluvium from slopes: 15 to 30 inches of brown to dark-brown silt loam over heavier silty material; 7, yellowish-brown silty clay loam, from which all the original soil has been washed off and from 4 to 6 inches or more of the subsoil; 8, non-arable land with abundance of limestone outcrops, most of the soil removed by erosion. (Surveyed by E. W. Knobel, Bureau of Chemistry and Soils, 1927.)

When it rains the material of the loose sandy beds beneath the subsoil clay readily washes out, with the result that huge chunks of the overlying soil and subsoil topple into the gullies. Gully growth by this process is rapid, extension being fastest by the heads, which follow up minor depressions in the surface, in many places having cut through formidable ridges, even those occupied by forests.

This *head-on extension* type of deep gully erosion can be controlled economically only by stopping the washes before they have cut down into the unstable substrata.

EROSION IN THE DRIER REGIONS

It would be reasonable to assume that in the dry regions of the West, where precipitation is often less than ten or twelve inches annu-

ally, soil erosion is far less active than in the humid regions. Such is not the case, however, at least for numerous localities, where structural soil features and scantiness of vegetation contribute immensely to the wastage.

In the Trans-Pecos region of Texas and in central New Mexico a great deal of exceedingly destructive erosion is to be seen. Even over smooth areas occupied by valley-filling material, representing the accumulation of centuries, the soil has been bodily swept away or cut to pieces by a type of erosion that has been referred to as channel-trench erosion.[17]

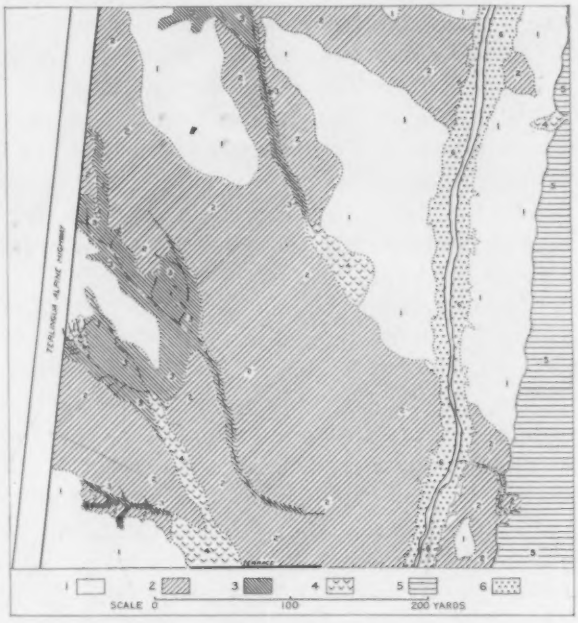

FIG. 17—Soil impairment by channel-trench and dry-climate-sheet erosion, southwestern Brewster County, Texas. 1, uneroded, or only slightly eroded: good Marfa clay loam; 2, half or more of topsoil removed: Marfa clay loam; 3, all soil and much of subsoil removed: severely dissected Marfa clay loam of low value; 4, accumulated erosional débris: silty clay loam, good soil; 5, upland: Brewster stony loam; 6, stream gravel. (Surveyed by M. W. Beck, Bureau of Chemistry and Soils, and T. C. Reitch, Texas Agric. Exper. Station, 1927.)

The writer saw last year (1927) literally hundreds of places where former valuable grazing areas had suffered from various phases of this type of wastage, to degrees varying from moderate impairment of the land to its absolute destruction. All of the eroded areas studied in this region had their beginning in roadways, cattle trails or bedding grounds, prairie-dog towns, or diversion ditches. The washing, in other words, had its start in those situations where the grass cover and ground equilibrium had been seriously disturbed. Structural peculiarities of the soil and, in places, coarse-textured basal material had contributed vastly to the rapidity of the erosion. As a matter of fact, the tendency of many dry-region soils to crack and recrack on drying, thus to form a loose fine-fragmental or granular surface layer, adds greatly to the erosional vulnerability of tremendous areas of the lands. This applies not only to desert soils but to subhumid types.

[17] Kirk Bryan: Date of Channel Trenching (Arroyo Cutting) in the Arid Southwest, *Science*, No. 1607, Vol. 62, 1925, pp. 338–348.

At Spur, Tex., for instance, on a two per cent slope 40 tons of soil were washed from one acre by 27 inches of rainfall, in a locality whose average annual precipitation amounts to 22.55, the minimum to 10.92 inches and the maximum to 35.61 inches. With heavy rains the chafflike soil is swept before rushing water as so much litter; then, with saturation, the emulsified mass flows rapidly down the slopes. Under the influence of this process enormous quantities of soil are swept into the streams and upon lower positions where it is not needed.

Another effect of dry-land soil structure is to assist erosion in a bi-active rôle. This is the common tendency of the heavier soils to split or crack vertically so as to develop a columnar structure. Washes begin in the fissures in some instances; and from the sides of gullies a splitting-off process, accompanying desiccation of the material, causes comparatively rapid wearage upon the exposed faces. This aids one gully to wear through to another much quicker than would happen in humid regions (Fig. 9).

In 1925 six square miles of the watershed of a stream near Redlands, Cal., were burned over; the following year 11 inches of rain falling upon the watershed in three days eroded the burned-over area and cut into the bed and stream banks of the valley, transporting and spreading débris over the lower valley floor, planted to oranges, to a distance of one and a half miles out from the point of debouchment of the valley from the highlands. The depth of this covering of loose, unfavorable gravel, sand, and silt ranged from a mere film to two feet through the groves. Where the depth ranged from six inches to a foot it proved necessary to dig the material away from the base of the trees. Where it exceeded a foot the orange trees began to die, and it was necessary to remove the detritus with the assistance of a steam shovel. It is said to have cost 60 cents a cubic yard to haul the material out of the grove, the average cost amounting to $1200 an acre. The expense of this operation was estimated to approximate the value of the land, and it is doubtful if the owners could afford to remove a second such deposit, even from the valuable orange groves.

A notable instance of destructive erosion following the removal of the vegetation from forest land by smelter fumes was observed last year in Shasta County, California, at Kennet. Here the vegetation was completely obliterated or very largely destroyed by fumes from a copper smelter over an area estimated as exceeding a hundred square miles. The original growth consisted of pine, live and deciduous oak, together with chaparral of manzanita, coffee berry, poison oak, etc., and the soil was a gravelly clay or clay loam. Partial rock decay had extended to depths of probably more than a hundred feet in places. On this hilly to mountainous area erosion has wrought unbelievable devastation. Deep, narrow gullies have riddled the affected area. Some of the trench incisions, with an estimated depth of 50 feet, wan-

der about like glacier crevasses; others spread widely in dendritic fashion. The soil is completely gone, and with it every vestige of forest mold. It will be interesting to watch the rejuvenation of this devastated area, by encroaching vegetation, now that the smelter has moved; that is if rejuvenation takes place before the decomposed material has largely washed down to bed rock.

And finally it should be noted that though its greatest damage is taking place over certain large critical areas—the Piedmont, the upper

FIG. 18—Along this stream twenty feet of alluvial material was deposited in fifteen years, and the land was rendered practically valueless.

coastal plain, the loessial region, the region of shale soils in the Appalachians, the regions having rolling soils with plastic clay subsoils, the heavy lands of the dry Southwest, and the overgrazed sheep lands in parts of Utah and other western states—this must not be construed as meaning that erosional wastage is not going on elsewhere. As a matter of fact, land impairment is proceeding in many places where its activity has not been suspected by the average farmer, even on soils that seem nearly flat.

RELATION OF EROSIONAL SEDIMENTS TO FERTILITY

A word should be said regarding the reverse of the erosional process. It is commonly believed that the products of erosion largely go to improve the alluvial plains over which part of the material is deposited in times of flood. From this angle of viewing the situation it is sometimes contended that floods are of great value, serving as a powerful instrument for soil enrichment. There is a germ of truth

FIG. 19

FIG. 20

FIG. 19—The bottom of this stream, Oconalufty River, Swain County, North Carolina, was formerly covered by a rich strip of alluvial land, as represented by the small island area in the center. (Photograph by E. Block, U. S. Forest Service.)

FIG. 20—Deep gullies and abandoned hillside farm land in the Blue Ridge Mountain section. White pine is slowly and difficultly restocking the area. (Photograph by E. Block, U. S. Forest Service.)

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FIG. 21

FIG. 22

FIG. 21—Erosional effects following overgrazing of sheep lands, Manti National Forest. (Photograph by U. S. Forest Service.)

FIG. 22—On this gullied slope in southern Ohio (Scioto County), locust trees have been planted to bring the wasted area to some degree of usefulness.

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in the idea, particularly with respect to some types of flood plain. In a large measure, however, the conception is fallacious. In the first place, as already pointed out, a large proportion of the eroded material comes to rest temporarily upon lower slopes and flats where it is not needed and often does serious and permanent damage to the land and the crops growing on it.

Furthermore, much of the most productive part of the flood-plain deposits is left upon material of precisely the same origin and character, already having great depth and good productivity. There is, of course, some temporary enrichment of the alluvial soil of some areas by deposition of fine-grained material. Even in the Mississippi flood plain, some increase in the crop yields follow deposition of the finer particles, especially on the more sandy strips along the stream banks. Not much advantage from this source can be expected, however, in case of the highly productive "buckshot" land of this great alluvial plain, the Sharkey clay, which is a deep soil rich in available and potential plant nutrients, often containing three-tenths per cent of phosphoric acid and a good supply of organic matter. Some temporary refreshment is frequently observed, nevertheless, in the older fields, due to the fresh organic matter and nitrates in the deposits. But the increased yields are generally not astounding nor of very long duration.

On the other hand, comparatively infertile material of sand and gravel is frequently deposited over productive alluvial bottoms, causing much damage. Even the floods of the Mississippi lay down patches of almost inert sand, locally known as "sand blows," and injure other areas by deposition of loose sand near the banks and in the vicinity of levee crevasses. The Vermont flood of 1927 laid down over productive meadow lands blankets of coarse sand and gravel that were six feet deep in places. Even boulders weighing a ton were rolled out on some of the alluvial plains. Many thousands of acres of the best land in the state were thus severely damaged or entirely ruined.

In any appraisal of the effects of floods, it is necessary, of course, to weight first the damage done to farm improvements, live stock, and crops. And it is well always to remember that one acre of alluvial material in a stream bottom may stand for many acres of impaired or devastated fields and pastures, upstream, especially when there has been abnormally rapid deposition.

Relation of Erosion to Floods

Inadequacy of measurements makes it entirely impossible to estimate the full relationship of soil erosion to floods. There is evidence, however, to indicate that erosion always tends to increase the volume of floods materially. There is abundant proof of this for the smaller streams, and it has not been proved that the same sort of thing does

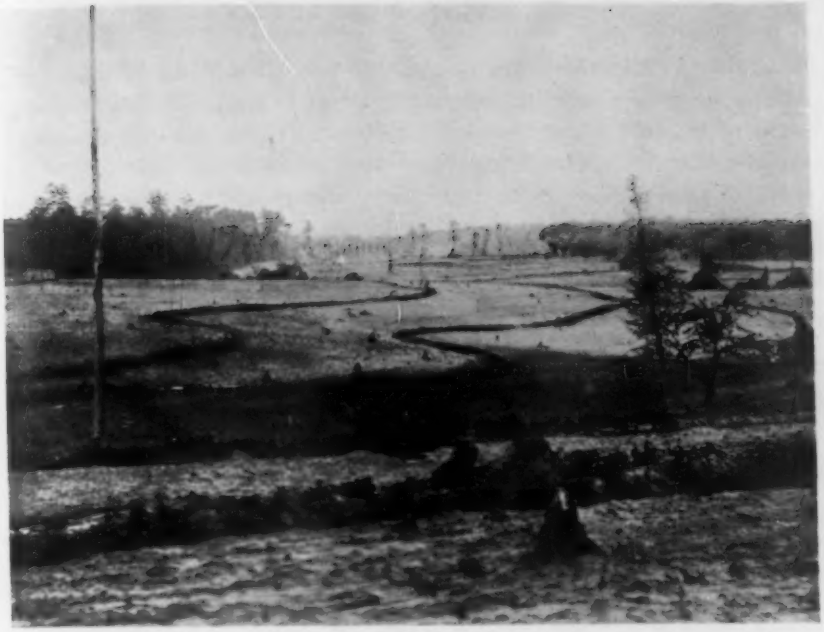

FIG. 23

FIG. 24

FIG. 23—A properly terraced field in the Piedmont region. Many fields in this region have been saved by such terraces.

FIG. 24—This Piedmont hillside, formerly a waste of gullies and exposed clay subsoil, has been reclaimed by the use of hillside terraces. The man at left stands on a flat of accumulated material caught by the terrace embankment.

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not take place in the larger streams, as the Missouri and Mississippi. We have entirely too little evidence relating to the rains that produced some of the earlier floods so often referred to by those who profess to believe that only conspiring rains and inadequate levee protection have anything to do with such disastrous floods as that along the Mississippi in 1927; and also there are too few precise data relating to these early floods themselves. It would not, however, in the least vitiate the argument of those who see a vital relationship between floods and denuded watersheds if some of the earlier explorers had looked upon floods in the Mississippi that very greatly exceeded the one of 1927, for there was then as now no natural law against overwhelming downpours. There is abundant evidence upon the pages of the world's history that every now and then all the probabilities have been rudely upset. This being true, they may be upset again. The important thing for mankind is not to permit improbable eventualities and unavoidable actualities (the rains) to constitute a negativating deterrent in the setting up of obstacles to those wasteful processes going on under more or less normal conditions.

The largely increased run-off and wash-off from unprotected slopes as compared with protected slopes cannot but add volume to the water of rising streams. Equilibria of current and load, balances of deposition and resuspension, eroding banks, eroding flood plains, etc., enter into the process, of course; but an increased volume of water in a stream is a definite enlargement that cannot be decreased except by part of the water getting away somewhere; and the place most of it must go is the sea, where it arrives as quickly as possible and in as large volume as possible, regardless of the methods of travel involved.

It is perfectly obvious that if a greater portion of water and of suspended and dissolved matter is withheld from the streams the flood hazards which occur at peak stages will be greatly relieved; and, furthermore, both the water and the soil are needed in the fields and pastures where they belong.

Looking Ahead

As a nation we are doing comparatively little to abate the evil effects of this scourge of the land, soil erosion. Those who know from actual experience and observation anything of the process admit it is a serious land problem; but few have seemed to realize how exceedingly devastating it is in its wholesale operation. There is immediate need for a tremendous national awakening to action in bettering our land practices. Terracing and contour cultivation of sloping areas to check erosion has been carried on with excellent results for a long time in parts of the southeastern United States. Recently the method has crossed the Mississippi and is being extensively and increasingly

employed in Texas and Oklahoma. But in the region north of the northern line of Oklahoma and Tennessee terraces are rarely employed to protect eroding slopes, or any other means for that matter. Most of the farmers have never seen an efficiently constructed terrace; many of them have never even heard of this embankment method of protecting sloping fields.

The terrace is a very practical implement for saving soil and also for conserving soil moisture in the drier regions. When terraces are properly built, including adjustment to soil and slope, they will pay their way many times over; and whatever they accomplish in holding soil in the fields, keeping it out of the streams, and storing moisture in the subsoil will be a by-product of the operation. In regard to this, however, as to other phases of the problem, investigational work has only begun. We do not yet know what is the best type of terrace for some of the most erosive soils; nor do we know at precisely what slope cultivation should cease on some of the more susceptible lands and the planting of trees or grass should begin. As yet only three types of soil, of the many involved, have had their erosivity measured.

ANCESTRAL OCCUPATIONS OF THE HUNGARIANS

E. D. Beynon

ANY attempt to reconstruct the life of the Hungarians of the *Honfoglalás*, or Home-taking, of 896 A. D. must rest largely upon a study of the primitive occupations which have been preserved into modern times. The past history of the Hungarians before that epochal year is almost purely legendary. The old Hungarian literature, if such existed, was completely destroyed at the time of the Christianizing of the Hungarians in the early part of the eleventh century. Copious annals and chronicles remain, it is true; but they are written in the Latin language and deal almost entirely with the political events of the successive reigns. We search in vain in the pages either of Anonymus or Kézei for information as to how the people themselves lived in that far-off day. The earliest writing that has been preserved in the Hungarian language is the Funeral Oration of the early thirteenth century, which does not greatly enlighten us as to how the people lived!

The generally accepted hypothesis of the origin of the Hungarians is that they are a Turanian people of the Finno-Ugric branch of the Ural-Altaic stock and that their closest living relatives are Ostyaks and Voguls who still roam the slopes of the Ural Mountains and the valleys of the Irtish and Ob in Siberia. Hungarian legend places the ancestral home of the Magyar race in "Jugoria," a sort of fabled paradise lying to the east of the Ural Mountains. Every source of information agrees on this, that the primitive Hungarians were hunters, fishers, and herdsmen and that before the Honfoglalás they lived in precisely the same manner as do the nomadic Ostyaks and Voguls of today, though through a false pride many Hungarians, including the great scholar Arminius Vámbery, have opposed this hypothesis.

It may be assumed that either through the natural increase in population or through the pressure of predatory tribes from the East life in ancient "Jugoria" ceased to be idyllic—became, in fact, so unbearable that the entire Magyar race decided to move westward and find a more suitable home. Some ancient legends give as the motive of the migration overexploitation of the wild life and pastures of the homeland. When the Carpathians had been crossed and the indigenous tribes had been conquered, the land presumably was parceled out among the conquerors. In appropriate places we may still find evidence of the ancestral life. Even to this day the shepherds and herds-

men of the Alföld, the fishermen on the banks of the Tisza and Danube, and the huntsmen in the fastnesses of the Bükk or Bakony Mountains preserve many of the customs held in common with Ostyaks and Voguls. But Hungary is rapidly becoming westernized, and all trace of the way the primitive Magyars lived will soon be obliterated, save for the cultural objects preserved in museums.

Ancestral Hunting

Hunting was the most primitive occupation. The greatest number of occupational words common to Hungarian and its cognate Finno-Ugric languages have to do with this activity. The oldest legends make Menrót—changed by monkish scribes into the Biblical form of Nimrod—the ancestor of the Hungarian people: and this Menrót was like Nimrod a famous hunter. Vastly fewer remains of primitive hunting, however, have been preserved than of primitive fishing or the pastoral life. While these latter remained sources of livelihood for the common people, hunting became reserved exclusively for the king, the nobles, and their servants. The ancestral Hungarians hunted for food, not as a sport. They were interested in catching the game as quickly and with as little danger as possible; hence they used snares, nets, pits, darts, nooses, and the like. The use of all these became strictly prohibited by severe poaching laws. At the time of the Millennial Exhibition of 1896, Nagy Géza, who was appointed to the oversight of this department, lamented his lack of success in securing exhibits of ancestral hunting.

The hunting methods of the Hungarians have passed through certain well-marked stages. Before the migration from ancient "Jugoria," the hunter with his horse and dog would hide in the shadow of some colossal tree to shoot the game with his arrow as it approached and then pursue with horse and dog. The most primitive weapon was the arrow, different types of which were employed for the hunting of different animals. It is probable that the *agár*, or greyhound of Hungary, was one of the animals brought by the invading Hungarians from Asia to their new home. Through the centuries the characteristics of this breed have greatly changed, for the original *agár* was larger, stouter, and had longer hair. In time the Hungarian huntsmen began the use of the lasso, which was thrown from horseback. Still later they employed snares and traps, the use of which has continued to the present time among poachers.

During the seventeenth century the musket began to come into general use for hunting purposes in Hungary; by the beginning of the eighteenth century it had completely superseded the bow and arrow. While the higher nobility used imported firearms, the squires and lower orders of the nobility used home-manufactured muskets until the prohibition of firearms after the War of Independence in 1848–1849.

FIG. 1

FIG. 2

FIG. 3

FIG. 1—Hunting the wild boar. The genuine "hunter type" is here depicted. (This and the following photographs are copyrighted by I. Kerny, Budapest.)

FIG. 2—Making the *varsa*. This net is used for catching eels.

FIG. 3—A *csikós*, or horse boy, drinking a libation—a survival of an old pagan custom.

Certain modes of hunting have never been popular with the Hungarians. The spear, commonly used by ancient German tribes, does not seem to have had great vogue among the Magyar people. The hunting knife was a very late importation into Hungary: until the fifteenth century the sword was used in its stead.

In former days game naturally was far more plentiful in Hungary than now. Owing to the nature of the country, most of the good hunting regions were ceded by the Treaty of Trianon either to Czechoslovakia or to Rumania; yet as long ago as 1896, while Hungary still retained her ancient borders, many lamented the dearth of game. Three valuable species were long since exterminated from Hungary—the beaver, the elk, and the aurochs. The Bükk, Vértes, and Bakony Mountains—which all remain in present Hungary—were anciently vast hunting grounds. A century and a half ago one young noble killed 220 deer in one afternoon.

In spite of the nobles' love of adventure, much of the hunting was not done by them, but by a separate caste, the Royal Hunters. This caste, scattered all over Hungary, was governed by the Lord Lieutenant of the Hunters and was divided into classes according to the different kinds of animals hunted. An interesting survival of this old régime still remains—the Royal Hunters of Szent Gál in the County of Veszprém. Though the Árpád dynasty which settled these people at Szent Gál has been extinct more than six hundred years, they still wear the ancestral hunting costume and observe the old twelfth-century customs.

In the fastnesses of the Bükk Mountains of the County of Borsod I met one day, not far from Szilvásvárad, the forester of the estate of Marquis Pallavicini. He was a typical hunter of the old time, like those of Szent Gál, descended from the Royal Hunters of the days of the Árpáds. These men have a different physique from that of other Hungarians. Might it not be that these Royal Hunters were largely composed of the ancestral hunter tribes?

Although the ancient methods of hunting were abolished long ago, they reasserted themselves during the troublous times connected with the régime of Count Michael Károlyi in the late autumn of 1918. The people of the villages crowded into the estates of the nobles. The destruction of game was terrific. The interesting feature of the matter is the way in which the peasants hunted the game from which they had been kept for so many centuries—in the same manner as their ancestors. Snares and pits were used; if a man could secure a horse, he hunted with its aid and used the pistol; or, failing that, he once more made bows and arrows with which to bring down the deer of the nobles.

Ancestral Fishing

Through the centuries the simple fisher folk of Hungary have changed but little, far less than those who follow other ancestral occupations. From prehistoric times they have preserved practically the same utensils and modes of fishing, practicing on the shores of the Balaton[1] and Fertő lakes and on the Danube, Tisza, Maros, Körös, and smaller rivers the customs they had carried on beside the Ob and later on the Volga.

The conversion of Hungary to Christianity greatly enhanced the importance of the fisherman's occupation. The need of a fish diet through Lent led the cooks of the nobles to devise all manner of fish dishes. In a cookbook of 1680 two hundred and thirteen such recipes are given. To augment the supply from rivers and lakes artificial fishponds were introduced, even before the battle of Mohács, which

[1] After the abolition of serfdom in the mid-nineteenth century the landlords insisted on the payment of rent for the ancient privilege of fishing in Lake Balaton: difficulties ensued and the people's fishing rights were completely abolished with the entailment of much hardship.

was fought in 1526. At the present time there is no more flourishing industry in Hungary than that connected with the artificial fishponds. Joint-stock companies with a capital of millions of korona have engaged in some of these projects, as that on the so-called "Bad Lands" of the Hortobágy near Debreczen. There is scarcely a noble who does not have an artificial fishpond on his estate, from which he expects

FIG. 4—Fisherman's hovel on the bank of the Tisza, showing the influence of modern commerce. The boat is no longer hollowed out of an oak trunk; canvas now covers the hut instead of woven reeds; the nets have been greatly modernized.

to derive the largest portion of the year's profits. While long ago trout were raised in this way, it was found in time that carp could be raised and fattened more quickly and could find a readier market among a certain class of the population of great cities, both in Hungary and in Poland. Nothing savors less of the romantic past than the efficient business management of the carp-raising industry.

On the other hand the fisher folk along the rivers and lakes use almost the same fishing methods as did their ancestors of a thousand years ago. They do not send the fish they catch to foreign markets; what they have caught the night before they bring to the early morning market in the city nearest them. In all Hungary I saw nothing more picturesque than the stalls of the fishmongers in the market place of Szeged. Even in the selling of fish a very ancient custom is preserved. The fish are fastened to an *ihany*, or wicker frame, so that the buyer may carry them home more comfortably. Hungarian ethnologists point out that a contrivance similar to the *ihany* is sculptured on Egyptian monuments.

Every phase of the life of these fishermen is primitive in the extreme. The hut in which they live has one of two forms—either a tall, conical and pointed structure, the so-called *pákászkunyhó*, made of reeds and resembling the capped hut, *kontyos kunyhó*, of the shepherds, or the form illustrated in Figure 4, which now consists of canvas fastened over a rough framework where formerly it was made entirely

FIG. 5—Shepherds watching their flocks on the plain of Hortobágy.

of reed and wickerwork. The latter form of hut is quite low and is left permanently open on one side but affords at least a partial protection from the wind and rain. The low hut in its original form was probably that used by the ancestral Hungarians.

The fisherman's canoe, *lélekvesztő*, consisted of an oak trunk from which the center had been burned out, a prehistoric type. Unfortunately this interesting survival is no longer used because it recently became impossible for the fishermen to find oak trunks large enough; while commerce has made it possible to buy boards and nails for the construction of a practical if less picturesque craft. The oar used by the fishermen of the Tisza, and especially by those of Szeged, is most interesting. The blade is shaped like a tobacco leaf. Other tribes have copied it but not accurately, their oars rather resembling a willow leaf. It is only on the banks of the Ob that we can find tribes using precisely the same kind of oar as that of Szeged.

The organization of the fishermen was rather significant. Companies, or *halászbokrok*, were formed with collective responsibility and collective privileges of fishing. Usually eight or ten men belonged to each of these companies. The waters—both lakes and rivers—were

divided among them. The fragment of a mast or a so-called guard tree, *őrfa*, was set on the shore of the borders of each company's territory. Men of no other company were allowed to fish there. This division of the waters among the companies of fishermen corresponded closely to the division of the boundless waste of the Alföld among the shepherds.

The modes of fishing were numerous. The most primitive contrivance was the *vejsze*, a sort of cane or reed fence with wedge-shaped pickets on the points of which crooked hooks were placed. This was fastened to the mud in the bottom by weights and could not be moved. For sturgeon fishing in the Danube, cables were placed across the river and provided with baited hooks every few feet to catch the fish as they came upstream from the Black Sea. Probably the most skillful fishing with hook and line, and at the same time the most primitive, was that employed by the fishermen in the great marshes known as the Ecsedi Láp in the County of Szatmár and the Sárrét in the County of Bihár; but these marshes have now been drained. An interesting method, which also has gone out of existence, was the *látott halászat*, or sight fishing of the Balaton. A watch would be stationed on the promontory of Tihany on the lookout for a school of *fogas*, the finest fish in Hungarian waters. The signal given, his companions would surround the school with their nets. In the shallower streams the large fish which lay sleeping and basking in the sunlight were harpooned. In winter on the Balaton fish were caught with nets through the ice. The people of two or three villages would all turn out on this occasion, which was regarded as one of the chief holidays of the year.

Different types of large nets were used, but the most distinctively Hungarian form was the *kuszakecze*, a three-cornered dragnet fastened to a wooden frame and dragged after a canoe. Stones around the wooden frame helped to weight the net down; but the net itself was kept in position by nine horse bones—on each side four metacarpal bones and in the center a tibia. The bones were perforated and through the perforation attached to the sinews of the net. The nets shown in the foreground of Figure 4 are modern adaptations. Somewhat similar to the *kuszakecze* is the long, conical *varsa*, used for trapping either fish or eels (Fig. 2).

All of these methods of ancestral fishing are rapidly passing into oblivion. While great care is taken of the artificial fishponds, the natural fishing grounds have been allowed to become almost "fished out." Steam navigation has done much to ruin the fisherman's occupation. The main reason, however, for the decline in ancestral fishing is that which has largely destroyed primitive pastoral life—the drainage of the Alföld and the regulation of its many waters into a few channels.

FIG. 6

FIG. 7

FIG. 8

FIG. 6—A landscape scene in the *Bugacs Puszta*, or steppe, of Kecskemét. Practically the entire herd is of aboriginal Hungarian cattle. This breed, which was brought to Hungary from Asia at the time of the Invasion, is white, long-horned, and exceedingly hardy.

FIG. 7—A *cserény*, or herdsman's house, in the *Bugacs Puszta*. This *cserény* is roofed and so shows a wide deviation from the primitive type.

FIG. 8—The market of the bridge of the Hortobágy, near the famous inn. This market, which was held annually on June 17, was attended by merchants from as far as Budapest and Vienna.

Pastoral Life

More than any other ancestral occupation the pastoral life was a direct continuation on the plains of Hungary of the old life led on the steppes of Asia. The nomadic Hungarians of the Period of the Invasion brought their flocks and herds with them from the old home of their race. It is practically impossible any longer to find the native Hungarian breed either of horses or of pigs; but to this day many of the herds of cattle, many of the flocks of sheep, many of the watchdogs are direct descendants of animals brought into the country in 896.

The Hungarians settled in their new home by tribes and clans rather than as individuals. Their animals were collective property, and hence the land pastured by them was left unfenced. At first only a small portion of the unfenced pasturage was set aside for tillage and the raising of grain, the so-called *ökörtilalmas*. Many survivals of this old state of affairs are yet to be found. Even now the villagers have communal rights to their forest and pasture lands, though they own the animals individually. There are, however, great cities like Debreczen which have corporate ownership of flocks and herds. Debreczen, as a city and apart from the property of its individual owners, owns 41,000 animals, of which 11,000 cattle, 4900 horses, 2300 sheep, and 2100 pigs are thoroughbred. These are pastured on the Great Plain of the Hortobágy, also the property of the city. Apart from the area needed for the city's herds and flocks there are extensive tracts rented to individual citizens for pasturing their animals.

As the majority of the people exchanged the pastoral for the agricultural life a definite class developed, the *pásztorok*, a term much wider than our "shepherd" as it includes those who tended horses, cattle, and pigs as well as sheep. Bátky Zsigmond, in describing this class, goes so far as to say that "they formed a state within the state." This at any rate is true: they remained apart from the villages both winter and summer. A halo of romance has encircled their life; but to us the most interesting thing about them is that they live today in almost the same way as Árpád's people lived in 896.

The principal division of these *pásztorok* was fourfold. Those who tended horses were called *csikósok*, a name which literally means "coltherds." Their class was the flower of the life of the plains; they were the heroes of the folksongs; they were and still are the attraction of the girls of the villages that surround the plain. The tenders of cattle were the *gulyások*, or herdsmen, a class but slightly inferior. Those who tended sheep were the *juhászok*, and the swineherds were known as *kondások*. The life of these men out on the plains was patriarchal in the extreme. Especially in the case of the *gulyások* and *csikósok* the little group formed a sort of organized state. At the head was the *főszámadó*, or head herdsman, literally chief accountant. Under him was the *számadó bojtár*, chief of the young herdsmen, who

stood midway between the ruling *főszámadó* and the common herdsmen, many of whom entered this life at as early an age as ten years. Finally there was the *lakos*, or housekeeper, usually some older, reliable man.

The *cserény*, or dwelling place of the herdsmen, probably retains almost the same form as that used by the ancestral Hungarians. It is merely a four-cornered enclosure, open on top and on one side. The walls on the other sides are made of reeds and canes woven together. Such a structure could be easily pulled down and quite as easily put up again. It suited a perfectly nomadic people: and these little communities of herdsmen were, and to some extent still are, nomadic. Because of accumulation of manure and other litter it has been the custom to take down the *cserény* and move elsewhere at least every eight days.

A bit of thatch put over one corner—that farthest removed from the open side—formed the so-called tent which protected the property of the herdsmen, their chests, saddles, wallets of bacon, and the like. Inside the enclosure, but beside one wall, was the *szolgafa*, a trestle from which was hung the iron kettle with its finely carved wooden spoon. This was the kitchen. Outside the enclosure was the *gunyapad*, on which rough bench the *számadó* often slept. In front of the *cserény* were poles to which cows were tethered at milking time. No picture of this primitive habitation would be complete without the *talyiga* or two-wheeled provision cart (Fig. 7).

The evolution of the *cserény* is very interesting. Its most primitive form gave place in time to the roofless but horseshoe-shaped *vasaló* of the Hortobágy and to the cone-peaked *kontyos kunyhó* of the Ecseg Puszta of Turkeve. In time thatched roofs came into use, and the thatched sides gave place to boards, the habitation becoming a rather squalid hut.

Each class of the *pásztorok* has its distinctive dress. The most striking, naturally, is that worn by the *csikósok*. His love of ornamentation extends not only to his own clothes but also to the trappings of his horse and all the articles large and small with which he is surrounded. While the artistic instinct seems more marked in the *csikós* and the *juhász* than in the other two classes, it is to a large extent common to all who follow pastoral life. The life itself, partly slothful, partly adventurous, seemed to stimulate greatly the desire to make things beautiful. When one sees the delicate and beautiful figures carved by these men in their spare time on the handles of their wooden spoons and ladles, on their saltcellars, on their whip handles, canes, and other articles, one is amazed at the artistic ability displayed. As this art will soon be a thing of the past, collections of these things should be made before they are all lost or destroyed.

RUSSIA: TERRITORY AND POPULATION

A PERSPECTIVE ON THE 1926 CENSUS

Benjamin Semenov-Tian-Shansky

State University and Central Geographical Museum, Leningrad

AFTER the discovery of America by Columbus a vast colonization movement sprang up among the nations of Europe in two directions, westward towards America and eastward to Asia. The late Russian geographer, P. P. Semenov-Tian-Shansky, has calculated that of all emigrants beyond the Atlantic and the Asiatic frontier from the end of the fifteenth century to the end of the nineteenth 72 per cent, consisting principally of Western Europeans, went to America, and 28 per cent, chiefly Slavs, emigrated eastward to the interior of Eurasia (Alexander von Humboldt's term), if the ethnographic boundaries within the territory of the Russian plain between the European and Asiatic nations of those days be taken into account—for Russia has never recognized the artificial division of the northern continent of the Old World into Europe and Asia.

The importance of the great Slavonic colonization eastward into the interior of Eurasia has not been duly appreciated in Western Europe and America. And yet if there had not been this movement, Western Europe would have been obliged to spend so much energy in fighting the Asiatic hordes of invaders from the East that sufficient strength would not have been left to colonize America. It was only under cover of the Slavs on the east that Western Europe was able to retain the classical purity of its civilization. This is confirmed by the famous invasion of the Huns in the fifth century, which caused a panic throughout all Western Europe, as also by later ones, the strength and impetus of which are so vividly described by the traveler G. E. Grum Grzhimailo (in a new work of capital importance, "Western Mongolia and Uriankhai") that even now, several centuries after these nomads' invasions have ceased, we shudder in reading of them. The repeated attempts of Western Europe to vanquish the specter of "Russian Imperialism," so-called (1604–1617, 1700–1721, 1812, 1854–1855, 1904–1905, 1918–1920), were ill-advised and invariably amounted to little, even when Russia was defeated, for they were attempts against the natural geographical conditions of the country, rather than its population. Napoleon's campaign to Moscow in 1812 is illustrative. The situation was well expressed by an Austrian prisoner sent to eastern Siberia in 1916. Appalled by the great distance he said: "You

Russians cannot be conquered, because, in case of defeat, you can always escape so far that it would be impossible to overtake you."

The Vast Extent of Russia

Whilst the movement towards the east was proceeding, accompanied by an armed struggle of the settlers with the Asiatic nomads, the Russian Empire was formed. In continuous extent of state territory from west to east, this Empire holds the record in the whole history of humanity. While Alaska was still a Russian possession the Empire measured 11,000 kilometers from Kalisz to Mt. Adams. Even now, when it has decreased to 9000 kilometers (Proskurov to Bering Strait), it exceeds the other great territorial units that the world has known—the medieval states of Mongolia and Arabia, 7000–8000 kilometers; ancient China, Persia, Macedonia, and Rome, as also the modern United States of America and Canada, 5000–6000 kilometers. Moreover, the great empires of antiquity in the Old World and the medieval Arabian caliphate were situated between the annual isotherms of 10° C. and 30° C., and the Mongolian Khanate between 0° C. and 30° C., while Russia extends between the isotherms of 20° of heat and 20° of frost—a range such as occurs in the continuous territory of no other state in the world. In Canada this range attains 30°, in the United States without Alaska 20° and even with Alaska not more than 38°, in China less than 30°. This enormous range is illustrated by the accompanying map of the thermal zones of Russia, showing the annual duration of frost (Fig. 1).

The Great Extremes of Climate

From this map it may be seen that about half of the territory of the present Soviet Union has frost during more than half the year, while in the remaining part of the country approximately as far as the northern limit of hot summers (above 20° on the average) a long period of the year, about one-third, consists of transitional seasons—a spring, with its protracted period of bad roads and river floods caused by the melting of snow, and a rainy autumn, also with its long period of bad roads. Moreover, throughout the greater part of the Soviet territory, as a result of its being geographically unprotected from north winds, a temporary and sharp return of cold weather not infrequently occurs. A considerable part of the territory of northern Russia is characterized by a permanently frozen subsoil, the area so occupied being more extensive than similar tracts in North America, if Greenland and the North American archipelago be excluded as being separate islands. This condition is a considerable drawback to agriculture and to construction that penetrates to any depth. Only some inconsiderable districts of the coasts on the Murman and on the

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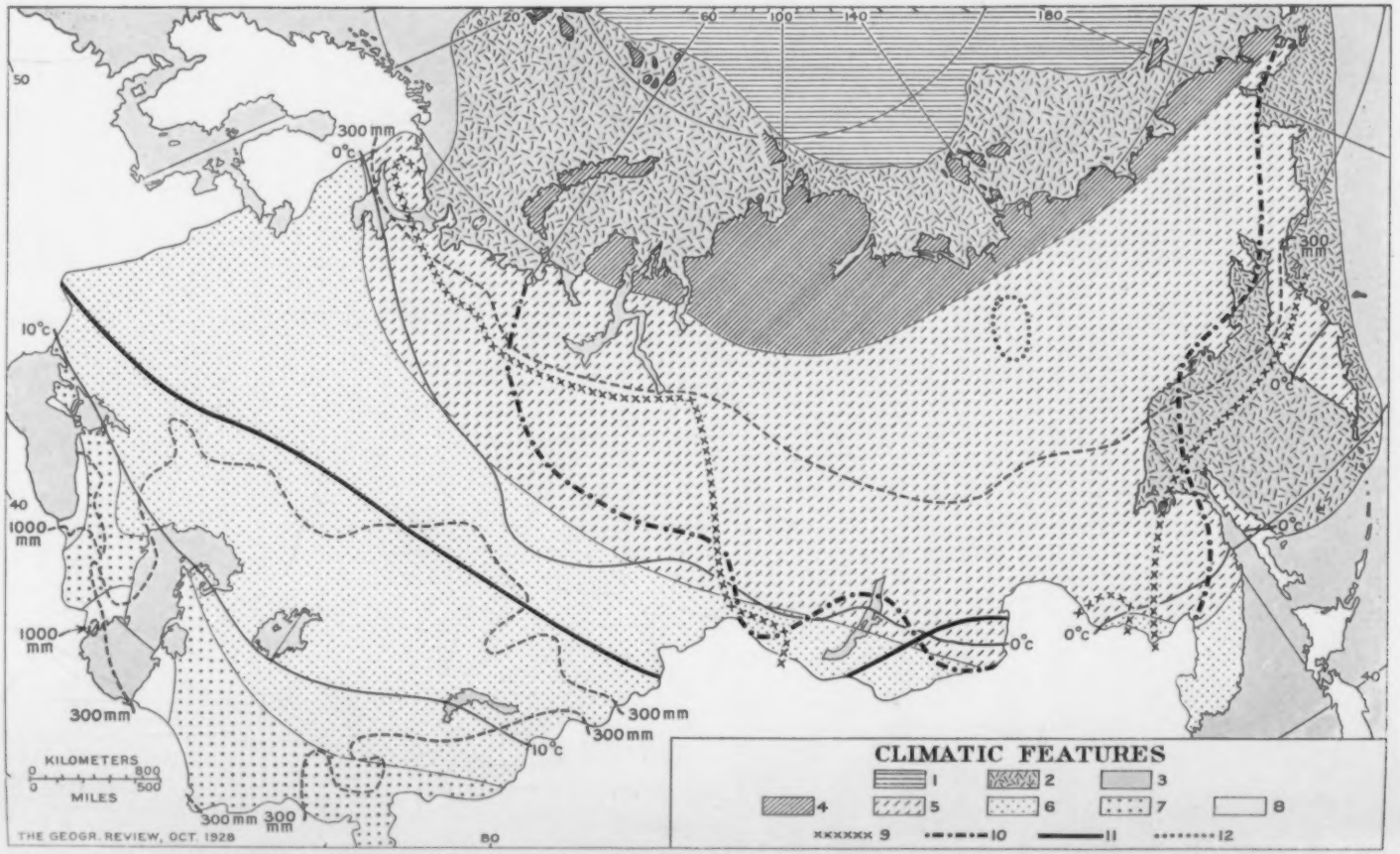
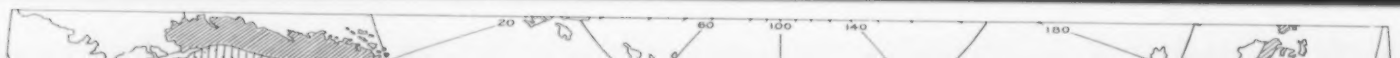


FIG. 1—Climatic features of Russia, compiled by B. and I. Semenov-Tian-Shansky. 1, sea almost completely ice-covered; 2, sea with floating ice; 3, sea ice-free in summer; 4–8, duration of frost—4, 9 months; 5, 6–9 months; 6, 3–6 months; 7, 1–3 months; 8, less than 1 month; 9, limit of permanently frozen ground; 10, limit of cold winters (more than 20° C. of frost); 11, limit of hot summers (more than 20° C. of heat); 12, January "Pole of Cold" (−45° C.). Mean annual isotherms 0° and 10° C. are shown and isohyets of 300 millimeters and 1000 millimeters.



4–8, duration of frost—4, 9 months; 5, 6–9 months; 6, 3–6 months; 7, 1–3 months; 8, less than 1 month; 9, limit of permanently frozen ground; 10, limit of cold winters (more than 20° C. of frost); 11, limit of hot summers (more than 20° C. of heat); 12, January "Pole of Cold" (−45° C.). Mean annual isotherms 0° and 10° C. are shown and isohyets of 400 millimeters and 1000 millimeters.

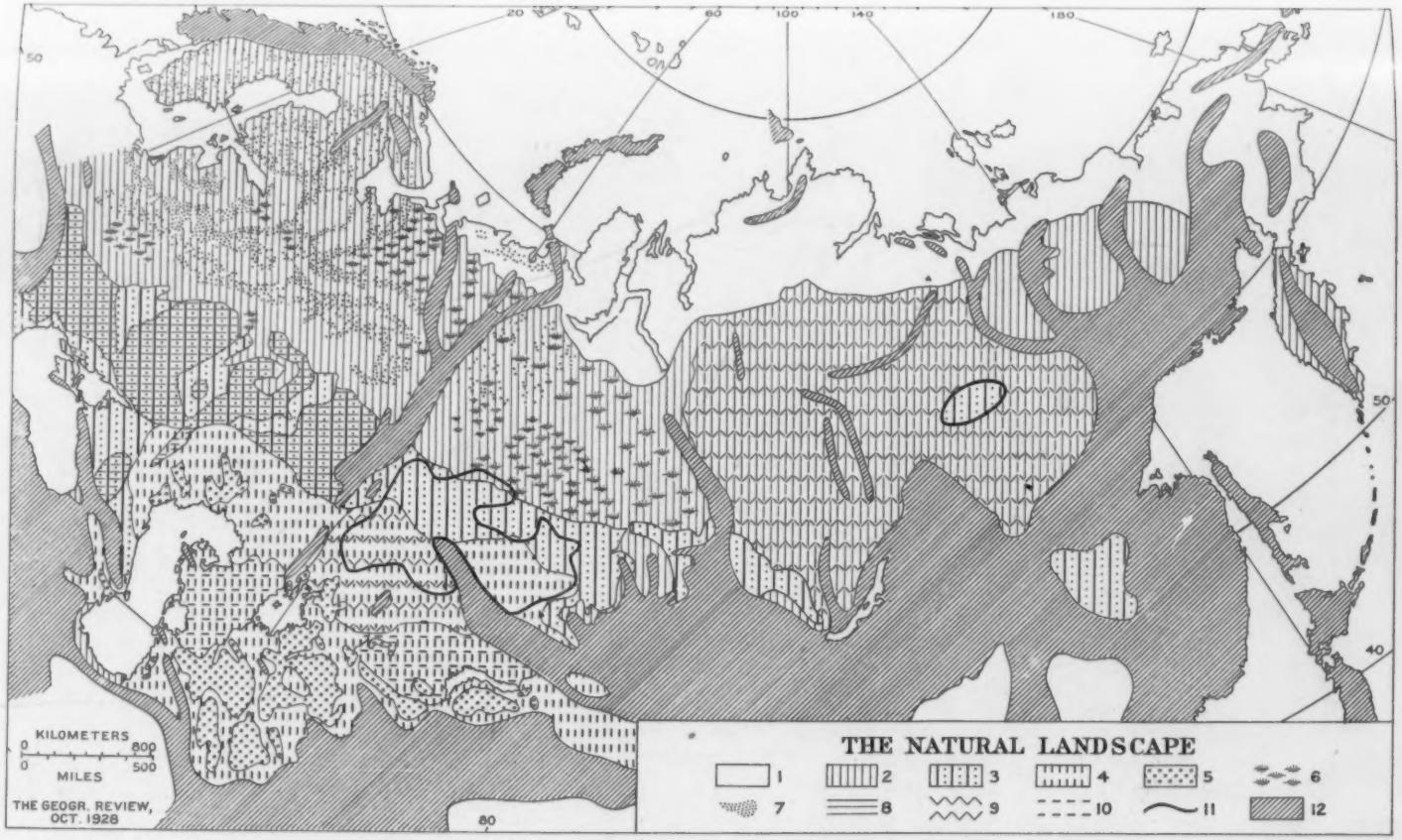


FIG. 2—The natural landscape of northern Eurasia, compiled by B. Semenov-Tian-Shansky. 1, tundra; 2, semiforest and forested plains; 3, semisteppe and steppe plains with black soil; 4, dry steppe and semidesert; 5, sand desert; 6, marshes; 7, hilly morainal landscape; 8, dissected plateau; 9, plateau with tabular uplands; 10, waterless plateau; 11, limit of lake-studded plains of interior drainage; 12, mountain landscape.

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Black and Caspian seas have access to waters that never freeze. Even Canada is favorably distinguished from Russia by possessing a longer coast line on the never freezing Pacific Ocean, not to mention the Atlantic, while having no extensive inland territory with a hot summer season. The Pole of Winter Cold (more than $-40°$) is situated in northern Greenland, not in the interior of Canada, whilst within the Soviet Union it lies in the interior near Verkhoyansk.[1] Within the boundaries of the Soviet Union frostless areas occupy but quite insignificant tracts on the coasts of the Black and Caspian seas.

On the other hand the territory of the Union with a hot summer has a low rainfall, less than 300 mm., and belongs to the region of semideserts and deserts (see Figs. 1 and 2). It is thus not astonishing that these severe natural conditions have reacted unfavorably upon the history of the country and that a low level of culture and slow progress have characterized the Slavonic colonizing movement towards the east. The country is, however, distinguished by the extraordinary adaptability of the race as recognized long ago by Elisée Reclus. During their eastward migrations the Slav settlers have shown a disposition to miscegenation with the primitive aborigines of the forest and of the polar regions, earlier acclimatized, as also with the nomads of the southern deserts. In this respect Slav colonization exhibits common features with that of the Spaniards of America who mixed with the natives. But the miscegenation of the Spaniards with the chief Indian peoples—those of the Aztec and Incan Empires for instance—was culturally more favorable, as the latter were already in possession of their own original fairly high civilization, while the cultural level of the tribes of Eurasia with whom the Slav mixed was for the most part very low.

And yet, even under these various adverse circumstances, nowhere but in Russia, as pointed out by Woeikov, is there such a dense population in such high latitudes. The yearly isotherm of 4° C. passes through Peter the Great's city, which had before the World War more than 2,000,000 inhabitants.

Centers of Territory and Population

Great Russia had its birth in the center of the plain of eastern Europe in the triangle between the Volga and the Oka, where was the cradle of the Muscovite dominion. From here it spread on all sides, though unequally, reaching the Arctic, Baltic, Black, and Caspian seas and the Pacific Ocean. This growth of the state territory was at times accompanied by losses on the borders, partly voluntary, partly enforced. Hence, the geographical centers of territory and population

[1] Sergei Obruchev on his recent journey in northeastern Siberia ("Discovery of a Great Range in Northeastern Siberia," *Geogr. Journ.*, Vol. 70, 1927, pp. 464–470) experienced extreme cold on the Upper Indigirka and suggests a possible extension of the "Pole of Cold" over that area.—Edit. Note.

have always been subject to change. The positions of these centers according to the general census of 1897 were calculated by the distinguished chemist Mendeleev in 1906 not long before his death. Later some corrections in his calculations were made by the physicist Weinberg, who also calculated the historical transpositions of the centers of the territory of the country and those of its population from the foundation of the Muscovite dominion until 1914.

The second general census of population took place in 1926. In connection with this census a special "Centrographical" Laboratory, named after Mendeleev and attached to the statistical section of the Russian Geographical Society, was founded under my direction. The mathematicians Sviatlovsky and Bobrik are there occupied in the determination, by weighing and numerical calculation, of the modern centers of territory, population, and various economic phenomena both for the whole Soviet Union and for the separate republics composing it.

As may be seen from Figure 3, the eastward movement of the center of territory was especially rapid in the seventeenth and at the beginning of the eighteenth century when the Russian Cossacks had reached Alaska, having rapidly succeeded in covering without check a space of thousands of kilometers in uninhabited high latitudes. In the eighteenth century the geographical center of the country lay almost on the watershed of the basins of the Yenisei and the Lena. Later, as lands in the west and south were annexed and Alaska was sold to the United States in 1867, that center began to recede in a southwestern direction and in 1914 reached Tomsk. The most extensive loss of border territory occurred in 1918 on the northwestern, western, and southwestern frontiers of the state, when Finland, Estonia, Latvia, Lithuania, Poland, Bessarabia, and a part of Armenia and Adjaristan were lost. But, as in 1918 only a strip of land, narrow as compared with the entire extent of the country, was lost, the center has not moved far, being now situated east of the river Tom between the Ob and the Yenisei.

The historical movement of the center of population was towards the southeast from Moscow, the movement being considerably slower than that of the center of territory. Thus from the beginning of the fourteenth until the beginning of the twentieth century, i. e. during 500 years, the center of population had moved from Moscow altogether a distance of little over 400 kilometers, as far as the government of Tambov, including a deviation to the west in connection with the annexation of the territories of the former Polish-Lithuanian state. The southward movement of the center of population was due to migration to the fertile black earth steppes. Here the nomadic population presented a serious obstacle. During the armed fight with the nomads in the sixteenth and seventeenth centuries, the Russian settlers built wooden turreted walls and earth ramparts and put up

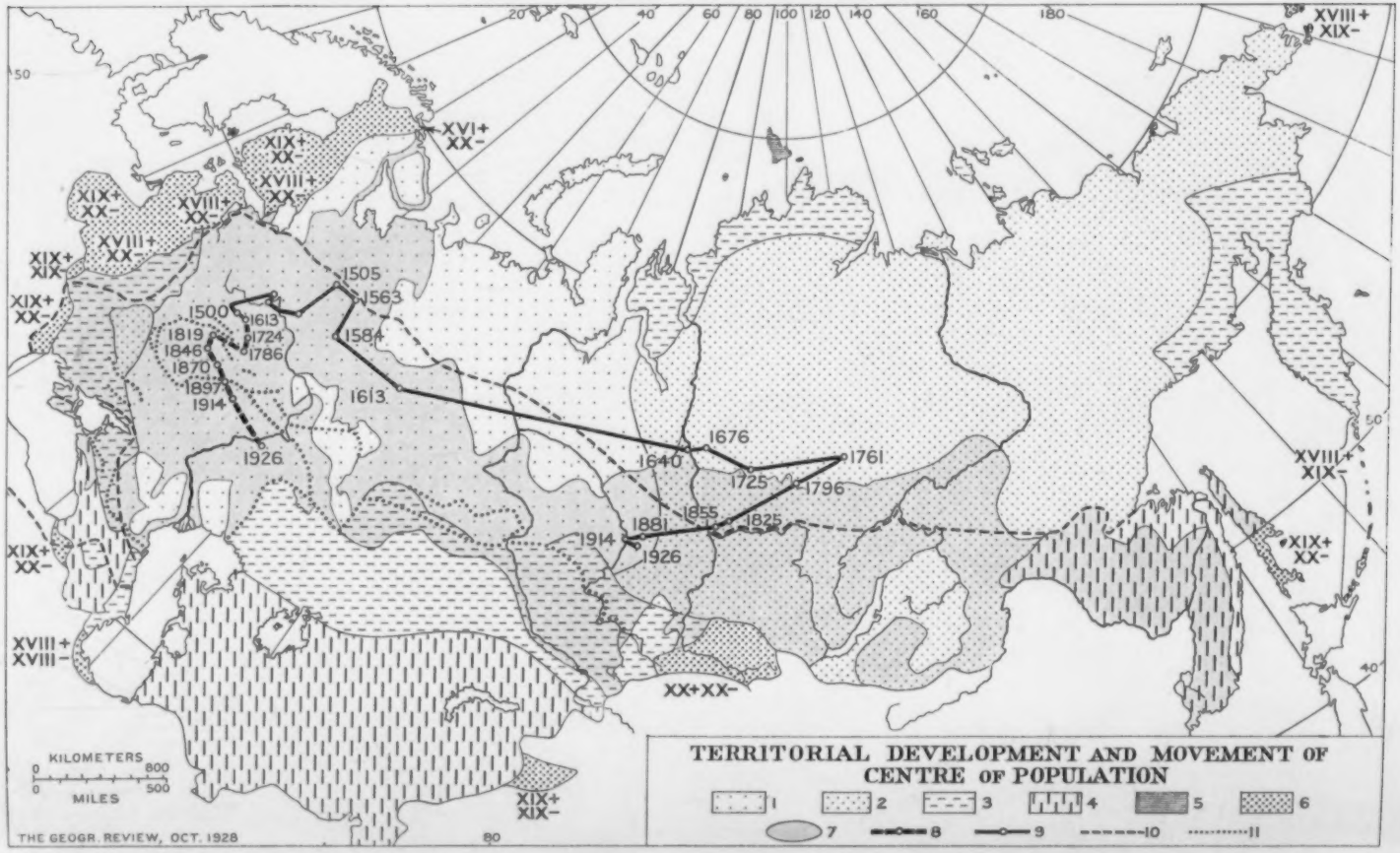

FIG. 3—Historical development, compiled by B. Semenov-Tian-Shansky. Territory acquired by Russia in: 1, sixteenth century; 2, seventeenth century; 3, eighteenth century; 4, nineteenth century; 5, twentieth century; 6, lost territories; 7, over 50 per cent Slavs in the population (twentieth century); 8, movement of center of territory from 1500 to 1926; 9, movement of center of population; 10, northern and western boundaries of the Mongolian-Tatar dominion of about 1300; 11, defensive lines against nomads and Caucasian mountaineers in sixteenth to eighteenth century.

to 1926; 9, movement of center of population; 10, northern and western boundaries of the Mongolian-Tatar dominion of about 1300; Caucasian mountaineers in sixteenth to eighteenth century.

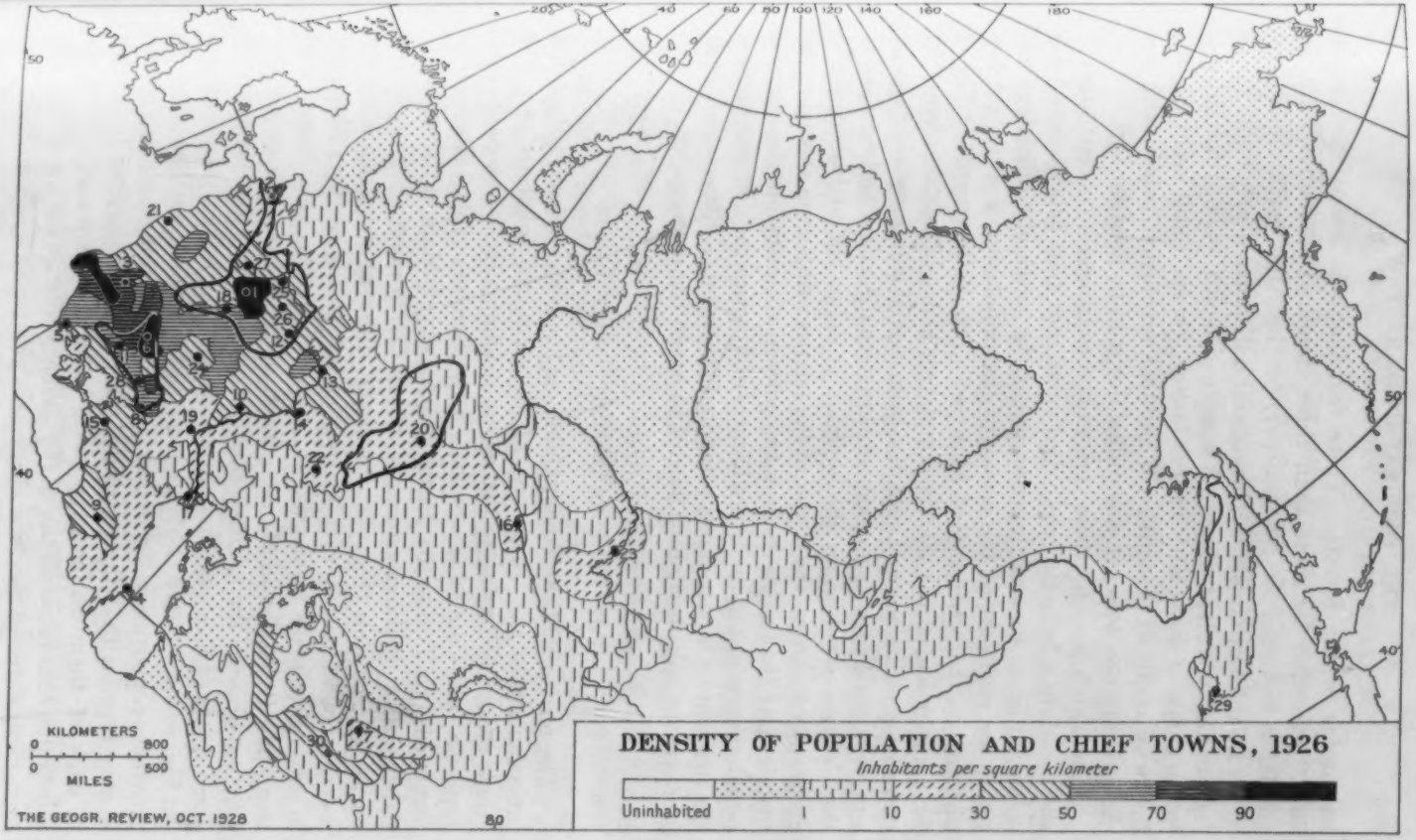

FIG. 4—Density of population and chief towns according to the census of 1926, compiled by B. Semenov-Tian-Shansky. Towns with over 100,000 are shown; the numbers correspond with the list of towns given in the text, Table I, on p. 635. The heavy lines enclose the three regions having the greatest development of urban settlement.

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barricades in the forests. These fortifications, known as "watch lines," extended for more than three thousand kilometers from the Desna, a tributary of the Dnieper, to the Altai, with an interval in the Ural Mountains, i. e. throughout a distance nearly equal to the famous Great Wall of China. A sample of such a wooden fortification in the shape of walls with towers (*ostrog*, "keep") still existed in the far-away north at Yakutsk till the last revolution, when with the exception of one tower it was pulled down to be used for fuel.

The watch lines by their very existence caused a concentration of the population behind them. And as at that time Siberia was being colonized in an eastern direction under the cover of similar fortifications, the resultant of the center of the population was a short line directed to the southeast of Moscow. The Polish territory lost in 1918 in particular was thickly populated, hence in 1926 the center of population of the Soviet Union has been moved comparatively rapidly and very markedly in an east-southeastern direction, and now lies in the German republic on the Volga. Thus, owing to historical and geographical causes, the center of the territory of Russia as seen on the map is more than three thousand kilometers distant from the center of population, whilst in the United States of America the distance between the two centers is only about a hundred kilometers. Russia must needs increase the colonization of Siberia to lessen the discrepancy.

The Peoples of the Soviet Union

The territory of the Soviet Union, as has been shown by the latest investigation of the Academy of Sciences, is inhabited by 169 ethnic groups belonging to ten major divisions: Indo-Europeans (36); Japhetic or Caucasian tribes (40); Semites (6); Finns (16); Samoyeds (1); Turks (48); Mongols (3); Tungus-Manchurian tribes (6) Paleoasiatics (9); and groups of tribes (4) from the Far East with an ancient culture (Fig. 5). So many different peoples throughout a continuous territory with no oversea colonies is hardly to be found in any other state of the world. Since the white race forms about three-fourths of the whole population of the Union, the yellow race only one-fourth, the country should be assigned to the Western civilized world of Eurasia, though not without a distinctly eastern cast. On Figure 6 are shown the boundaries of the republics and autonomous provinces constituting the Soviet Union. From this map and Figure 5 it may be seen that the republics are territorially so distributed that in each of them as far as possible there predominates one of the most numerous nationalities of the Union, while at the same time into each there enters a Slavonic element in greater or lesser degree. This occasionally gives rise to a markedly sinuous character in their boundary lines and even to a discontinuity of territory, parts of a

state being separated from the main body, as is the case in the Bashkir, the Buriat, and the Caucasian republics: but such is the inexorable working of the national principle laid down as the foundation of the territorial distribution.

Increase of Population

According to the second general census of December, 1926, Russia had 146,000,000 inhabitants. Thus, notwithstanding the losses caused by the World War, the civil wars, and the Revolution and despite the loss of territory with 27 millions of population now entering into the composition of seven independent states (Finland, Estonia, Latvia, Lithuania, Poland, Rumania, and Turkey) and also the loss from death by epidemics and famine, the population of the Soviet Union still exceeds by 17 millions that of the Russian Empire as it was almost thirty years ago, when according to the first general census of February, 1897, the population numbered 129,200,000.

This increase in the population is very unevenly distributed: it amounts to 164 per cent in the Far East, 140 per cent in Siberia, and 58 per cent in the northern Caucasus. It is true that these are districts of interior colonization; still the natural growth of the local population has also been great. In former times natural increase was checked by the great mortality of children under one year of age. In recent years this has been visibly lessened, and progress in this respect will be more rapid in the future. The growth of the population in the central parts of the Russian plain (24 per cent) was not high, nor was it in the Usbek and Turkoman republics (28 per cent), nor in Daghestan (8 per cent). The famine of 1921 caused a decline of population between the years 1920 and 1926 in the areas affected: in the government of Samara, as much as 18 per cent; in the German republic of the Volga, 17 per cent; in the Troitsk district of the Ural province and the government of Orenburg, 16 per cent; in the Tatar republic, 14 per cent; in the Bashkir republic, 12 per cent.

Among the federal republics forming the Soviet Union the first place in number of inhabitants goes to the Russian republic with 100.5 millions; then follow the Ukraine with 28.9; Transcaucasusia, 5.8; Usbekistan, 5.1; White Russia (abnormally diminished by territorial loss), 4.9; Turkmenistan, 1.

Geographical Distribution of the Sex Ratio

The geographical distribution of population according to sex is an important question to which too little attention is paid. In 1897 the population of the Russian Empire was equally divided as regards sex. In the northern half of the western part of the country women predominated, irrespective of race, and vice versa in the southern half.

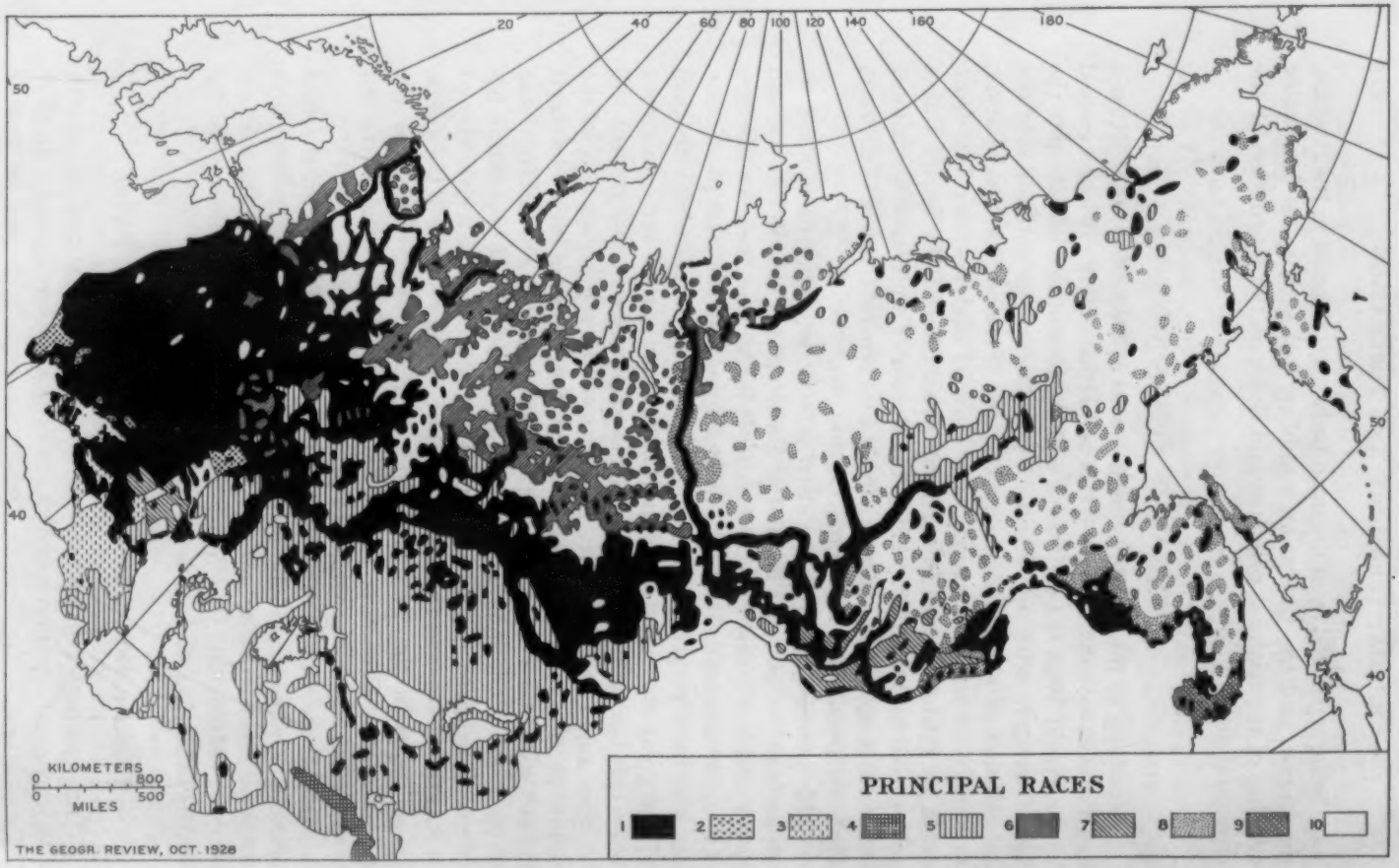

FIG. 5—Principal races of Russia, compiled by B. Semenov-Tian-Shansky from maps of the Special Commission of the Academy of Sciences of the U. S. S. R. 1, Slavs; 2, Rumanians, Germans, and Greeks; 3, Japhetic peoples and Ossets; 4, Iranians; 5, Turkic peoples; 6, Finnic peoples and Samoyeds; 7, Mongolic peoples; 8, Tungus and Paleo-asiatics; 9, Koreans and Chinese; 10, uninhabited or practically uninhabited territory.

2, Rumanians, Germans, and Greeks; 3, Japhetic peoples and Ossets; 4, Iranians; 5, Turkic peoples; 6, Finnic peoples and Samoyeds; 7, Mongolic peoples; 8, Tungus and Paleo-asiatics; 9, Koreans and Chinese; 10, uninhabited or practically uninhabited territory.

FIG. 6—The republics and autonomous provinces of the Soviet Union. I, Russian Republic; II, Republic of the Ukraine; III, White Russian Republic; IV, Moldavian R.; V, Karelian R.; VI, Chuvash R.; VII, Mari Autonomous Province (Cheremisses); VIII, Votsk A. P.; IX, Komi (Zyrian) A. P.; X, Tatar Republic; XI, Bashkir R.; XII, Republic of the Germans of the Volga; XIII, Kalmuck A. P.; XIV, Crimea A. P.; XV, Cherkess-Adigei A. P.; XV², Karachai A. P.; XVI, Kabardino-Balkar A. P.; XVII, North Ossetian A. P.; XVIII, South Ossetian A. P.; XIX, Ingush A. P.; XX, Chechna A. P.; XXI, Daghestan; XXII, Georgian R.; XXIII, Abhazian R.; XXIV, Adjar R.; XXV, Armenian R.; XXVI, Nakhichevan R.; XXVII, Azerbaijan R.; XXVIII, Karabakh A. P.; XXIX, Kazakstan (Kirghiz) R.; XXX, Turcoman R.; XXXI, Kara-Kalpak A. P.; XXXII, Badakhshan A. P.; XXXIII, Usbek R.; XXXIV, Tadjik R.; XXXV, Kara-Kirghiz R.; XXXVI, Oirat A. P.; XXXVII, Mongolo-Buriat R.; XXXVIII, Yakut R.

Climate is apparently responsible. It is well known that female infants endure the inclemencies of the season better than male infants who, in particular, are susceptible to the catarrhal diseases that are more prevalent in a cold and damp climate. The territorial limit of the numerical predominance of women in European Russia in 1897 may be said to correspond roughly with the annual isotherm of 7° C. According to the 1926 census it has moved southward to about 14° C. This is largely to be attributed to the series of calamities that overwhelmed the country from 1914 to 1921 and which affected chiefly the male population. The Transcaucasus alone has retained an insignificant excess of men, the ratio being 50.8 per cent against 54 per cent in 1897.

In all Asiatic Russia except the government of Tobolsk, which was first colonized (last quarter of the sixteenth century), there was a considerable predominance of men in 1897, as is characteristic of pioneer regions. On the shores of the Pacific the ratio of men to women was 68.4 to 31.6; and on the island of Sakhalin, then a convict colony, 72.9 to 27.1. Now the tables are turned, and throughout all Siberia proper the ratio of women to men is 50.9 to 49.1. In the Buriat-Mongol republic the members of the sexes, however, are almost equal. East of the Baikal the male population is still in excess. In the Far Eastern republic the ratio is 52.5 to 47.5. In the Yakutsk republic the ratio of men to women is 54 to 46, whereas in 1897 it was 51.9 to 48.1. The decline in the proportion of women is to be ascribed to the high mortality among women in their prime, the cause of which is now being investigated. In general it may be observed that the recent loss of man power has overburdened woman with work with injurious effect.

Climatic and historical factors affect most broadly the distribution of the sex ratio. As to the influence of the racial and economic factors the census returns have not yet been sufficiently worked out for analysis, though this is contemplated as one of the first problems to be treated by the Academy of Sciences.

Geographical Distribution of Population

The geographical distribution of population in Russia has depended on three major factors: climate, natural fertility of the soil, and the direction of the colonization movement. The net result has been a settlement very far from uniform: it differs from that of Western Europe in the existence of sharply alternating belts of densely inhabited and uninhabited tracts. Such a distribution cannot be properly shown on statistical cartograms, which usually are based on extensive administrative areas.

For an adequate presentation I have resorted to what I call the "dasymetric" map. Thanks to the active coöperation of Professor

P. A. Palchinsky and the Scientific Institute (for the study of "Surface and Mineral Resources") under his charge, such a map, "Dasymetric Map of European Russia," is in course of publication under my direction.[1] It is based on the 1897 census, with revisions up to 1915, and is on a scale of 1:420,000. Up to date more than 40 sheets have appeared. A new dasymetrical map of the whole Union on the scale of 1:1,000,000 for the European area and the Caucasus, of 1:2,000,000 for the more densely populated southern half of the Asiatic portion, and of 1:4,000,000 for the whole Union, based on the data of the 1926 census, is now being prepared by the Academy of Sciences under my editorship and will appear in the course of a few years.

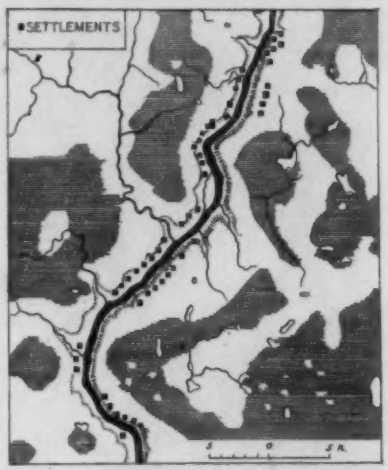

FIG. 7—Type of settlement in the north, i. e. in the valleys and along the waterways. This is a part of the valley of the Northern Dvina with a population density of 70 per square kilometer in the inhabited area.

TYPES OF SETTLEMENT IN EUROPEAN RUSSIA

On the basis of the studies for my book "Town and Village Life in European Russia" (1910) and the dasymetrical map I recognize ten different types of settlement on the Russian plain. Three of these are widespread.

Settlement in the northern belt is preëminently concerned with the collective industries—hunting, fishing, and extraction of the forest products; only in small degree is it agricultural. Settlements occur exclusively in river valleys and on the shores of lakes and seas, while the watersheds with their peat bogs remain entirely uninhabited. This type is well developed throughout the basin of the northern Dvina, Onega, and other northern rivers.

Settlement on the central watershed region on glacial soils is characterized by the cultivation of flax and cereals. Here the valleys are very humid and the frost season of long duration; hence the population prefers small sheltered villages on the clayey morainic hills and hillocks, warmer and drier but still with the ground water at no great depth. On an average the season for ripening of field crops is ten days longer on the higher land than in the valley bottoms. This

[1] See the review by Professor Sten De Geer (*Geogr. Rev.*, Vol. 16, 1926, pp. 340–341) in which he makes comparison with his own dot method. Professor Max Friedrichsen in "Die dasymetrische (dichtemessende) Karte des Europaischen Russlands," *Petermanns Mitt.*, Vol. 70, 1924, pp. 214–215, and Professor Palchinsky in the journal *Poverkhnost i Nedra* (*Surface and Mineral Resources*), Vol. 4, 1926, pp. 50–55, also discuss the matter and point out the suitability of my method to conditions obtaining in Russia.

type is found in the northwest of the Russian plain and in the center between the Volga and the Oka.

Settlement of the southern type occupies the valleys of the black earth region of wooded and grass steppes. Agglomerations are considerably larger and are situated on the high and often precipitous banks of streams, safe from inundation by the melting snows of spring. In places the settlements practically adjoin, so that they seem to form a narrow band stretching for tens of kilometers and making it difficult to distinguish where one ends and another begins. And yet the inhabitants when compelled to move through stress of growing numbers very unwillingly take to the watersheds, preferring emigration to Siberia or the northern Caucasus. Settlements of this type may be attributed initially to the conflict with the Asiatic nomads who grazed their herds on the vegetation of the watersheds and drove the settlers to the wooded valleys. Now the population does not care to dig the deep wells that are necessary to reach the ground water far below the surface.

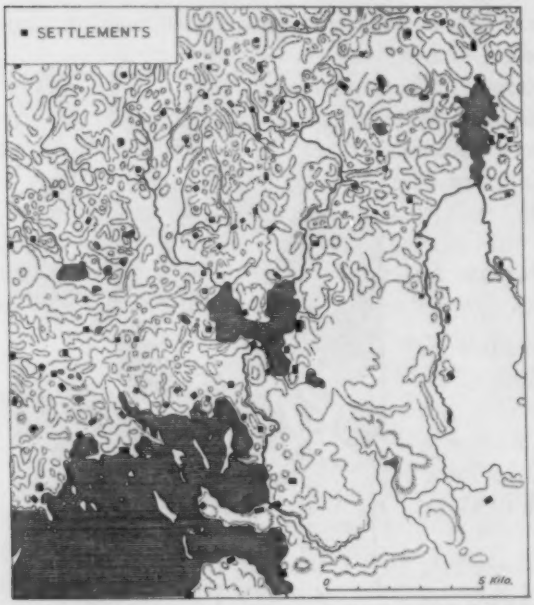

FIG. 8—Type of settlement in the northwest of the Russian plain, on morainic hillocks. In the inhabited area the population density is 22 per square kilometer.

The other forms of settlement are: the highroad type on causeways and ancient highways; the railway type, near railway stations, commercial or summer-residential in character; health resorts, a variety of the summer-residential type; the factory type of industrial districts; the metallurgical and mining type of the mining districts; the fishing type; the southern orchard type on the slopes of the Crimea and the Caucasus, where conditions are specially favorable to the growth of fruit trees.

DENSITY OF SETTLEMENT

On the whole the density of settlement on the Russian plain increases regularly from northwest to southeast. In the glaciated districts of the northwest with slightly dissected relief the average

is 30 to 100 inhabitants per settlement; on the clay tracts bordering on the black earth zone from 100 to 200; on the black earth zone 200 to 600 and frequently more, up to 1000. The limit of the black earth is at the same time that of large settlements *en masse*. The largest settlements of this zone, though numbering more than 10,000 inhabitants in individual cases, nevertheless often retain a purely rural character and cannot be ranked as towns. This peculiarity, as Woeikov has pointed out, also occurs in Hungary, Sicily, and the Balkan countries with similar agricultural character.

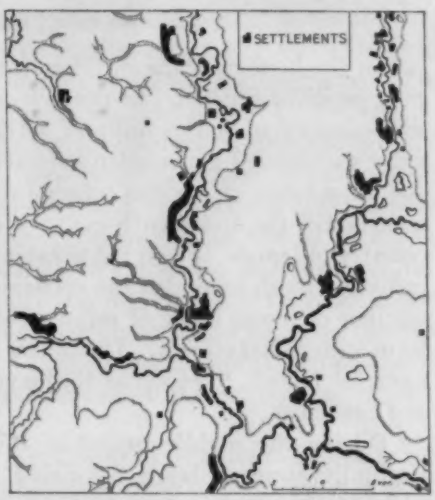

FIG. 9—Type of settlement in the steppes, on the stream banks. Density of population in the western valley 300, in the eastern 500, per square kilometer.

In Russia dispersed settlement has always met with some or other obstacle, natural or historical. To the former category should be assigned the depth of the water table on the watersheds of the southern half of the Russian plain and the winter frosts with snowdrifts which compel the people to congregate in rather large settlements for mutual warmth and protection. To historical causes may be referred the necessity of defense from the nomads as well as the unwillingness of the communes to allow their members to settle on independent plots. In the forest zone, where the forest is itself a shelter from the cold winter winds, the settlements are smaller, but the danger of losing cattle from wild beasts has in this case also caused close settlement.

The northern limit of the black earth zone generally forms the boundary between the watershed type of settlement and the ribbon-like valley type; and about the boundary is the zone of densest village population on the Russian plain, extending from Podolia to the estuary of the Kama, which I call the principal axis of colonization because it yields the greatest number of emigrants to the Asiatic part of the Union and to the northern Caucasus.

The American economist Carey[2] formulated a law regarding the pioneer: that agricultural settlers in colonizing a virgin country do not at first occupy the most fertile soils but those that can the most easily be worked with the tools available to them. This law has proved true in relation to Russia. Even now the densest population is not to be found on the black earth of the steppes but on the less fertile clay

[2] H. C. Carey: The Past, the Present, and the Future, Philadelphia, 1848.

soils near the northern limit of the zone. Only as these soils have become exhausted through continuous cropping has the population moved southward into the black earth steppe proper. In the country of clay soils the growing population has turned to industry. Here in the geographical center of the Russian plain originated the Moscow industrial district, which has politically assimilated the whole plain and occupied Siberia.

The Development of Towns

In the history of the development of towns in Russia four periods may be distinguished. In the first, or ancient, period the towns were exclusively founded as military settlements. For the most part they were surrounded by wooden turreted walls and ditches. Because of the abundance of wooden fences in ancient Russia the Scandinavian writers till the fourteenth century called Russia "Gardhariki," the country of fences. From the wooden town walls in the direction of the radiating roads extended the settlements of the soldiery. The greater number of towns being of military origin, they still have a concentric form with radial streets. The center, if built of stone, has retained the name of Kreml, "keep," as for instance in Moscow, Nijni Novgorod, and Smolensk.

During the middle period of town development western Russia gradually annexed lands belonging to the Polish-Lithuanian realm, where town settlements enjoyed the Western European medieval rights under the "Magdeburg Law," with privileges in trade and handicrafts, and where Jews were allowed to settle. Thus in Russia for the first time appear chartered towns. They are easily recognized by the tiled roofs of their buildings. They did not spread farther east.

The modern period commences when the Moscovite state became the Russian Empire, in the beginning of the eighteenth century, and when the interior of the country was now so secure that there was need for administration centers rather than military outposts. By that time nearly all the ancient wooden fortifications had disappeared, and many concentric towns had been transformed on a rectangular plan with a central market square, in which was situated the stone cathedral, surrounded by administrative buildings generally also of stone. The houses of the ordinary citizenry were still mostly wooden with iron or shingle roofs.

In the latest period, beginning in the nineteenth century, industrial towns began to arise; and in the second half of the century, commercial towns along the railways. Thus the principal stations of the old railway line between Petersburg and Moscow have during the 77 years existence of the line all become towns, and in their neighborhood many other small towns and boroughs have arisen.

The towns of Siberia, like those of European Russia, were first founded with purely military and administrative aims and had a similar appearance, but their population displayed a peculiarity in that it consisted of political and criminal convicts who afforded a supply of free labor for any kind of work. Many Siberian towns had been originally founded in haste to insure a greater hold over the natives: when they were no longer needed for that purpose and were situated unfavorably as regards geographical conditions, they simply disappeared. Potanin notes some curious features in the influence of trade on the Siberian towns. In western Siberia commerce was chiefly in cheap and bulky farm produce, such as grain and leather; whereas in eastern Siberia it was chiefly in expensive, light-weight goods, such as gold, fur, and tea. The merchants of western Siberia, before the building of the Trans-Siberian railway, restricted their annual journey to the fair of Irbit on the Ural and other Ural towns; while the merchants of eastern Siberia made longer journeys to the more highly civilized centers of European Russia—Petersburg, Moscow, the fair of Nijni Novgorod; which procedure was reflected in the greater degree of civilization in the towns of the east notwithstanding their greater distance from European Russia. Civilization here was also promoted by the Decembrists, exiled in the twenties of the last century in great numbers to far eastern Siberia.

The general conditions of the towns of the Russian plain and Siberia are still on a considerably lower level than those of western Europe; and they have not improved in the last 12 years, for many buildings that were destroyed have not yet been restored.

A particular type of town is represented by those of the southern mountainous countries belonging to the Soviet Union. In the Crimea and on the northern slopes of the Caucasus many towns are garden cities, thanks to their function as health resorts. In most of the towns of Transcaucasia the rural character of the population predominates, especially in Kolchis, central Armenia, and Azerbaijan, although it is just in these parts that the largest centers are situated—Tiflis and Baku. The towns of Transcaucasia have a rather pronounced eastern character, and with the exception of the greater number of the newly built towns on the Black Sea between Novorossiisk and Batum, which have an entirely European aspect, they are not distinguished for cleanliness.

Towns in Turkestan

Slavonic colonization on reaching Turkestan found numerous populous ancient towns of the type of Samarkand, Tashkent, Bukhara, Khiva, and the like in the oasis of the river valleys. Without infringing on their integrity the Russian authorities founded side by side with the

native towns spacious Russian settlements of the garden-city type. Also, for administrative purposes, a series of new towns, originally purely Russian, was founded in former wastes, such as Vernyi, Askhabad, Krasnovodsk. When the Central Asian and Tashkent railways had been built and artificial irrigation increased, colonists from the Russian plain were induced to emigrate thither, whence these towns acquired a new economic importance and grew rapidly. In the former Khanates of Bukhara and Khiva, which attracted few Slavonic colonists, the town population was less numerous. With the exception of Bukhara there were then no big towns, though the number of towns in both these Khanates, reaching as many as 35 to 40 in comparison with only 100 towns in the whole of Asiatic Russia, must be considered large. Here rural Asia, according to Woeikov's expression, has made itself felt. The native towns of central Asia have on the whole a rustic appearance, are dirty and crowded, and have but few stately monuments of Moslem antiquity: they contrast sharply with the adjoining Russian garden towns.

Classification of Towns

After the Revolution a considerable change was made in the official classification of towns. Now every place in which industrial life is developed, though it may have fewer than a thousand inhabitants, is regarded as a town. A distinction, however, is made between a "town" and a "settlement of the town type." A greater number of fairly populous towns have made their appearance, of which nobody formerly was aware; but, as the names of many of these places have also been changed without their previous names being indicated in the official records, it is a matter of extreme difficulty to compare them in detail with their originals.

Increase of Town Population

The town population of the Soviet Union according to the census of 1926 amounted to 25,734,418 persons, or 17.6 of the total population. In 1897 the returns gave the town population, which included their suburbs, as 13 per cent. This calculation, however, fell below actual conditions, since many important centers of the town type were ignored in the official list. In my book "Town and Country in European Russia" (1910) I attempted to introduce the necessary correction for European Russia without Finland and Transcaucasia, whence I obtained 15 per cent, beside which 3.5 per cent constituted a semi-municipal population and 31 per cent that part of the entire population that was engaged in other than rural occupations. As in the Asiatic part of Russia, which did not enter into my calculations, the town population was less developed, the general percentage of the town

TABLE I—THE PRINCIPAL TOWNS OF RUSSIA: POPULATION IN 1897 AND 1926*

	1897	1926	PER CENT INCREASE
1. Moscow	1,035,664	2,018,286	95
2. Petersburg (Leningrad)	1,267,023	1,611,103	27
3. Kiev	247,432	493,873	99
4. Baku	112,253	446,832	298
5. Odessa	405,041	411,111	1.5
6. Kharkov	174,846	409,505	134
7. Tashkent	156,414	320,865	105
8. Rostov-on-Don	119,889	304,812	154
9. Tiflis	160,645	279,565	74
10. Saratov	137,109	211,765	54
11. Ekaterinoslav (Dniepropetrovsk)	121,216	187,644	54
12. Nijni-Novgorod	95,124	181,189	90
13. Kazan	131,508	174,732	33
14. Samara	91,672	171,952	88
15. Ekaterinodar (Krasnodar)	65,697	161,965	146
16. Omsk	37,470	161,475	328
17. Astrakhan	113,001	152,543	35
18. Tula	111,048	149,172	34
19. Tsaritsyn (Stalingrad)	55,967	147,184	163
20. Ekaterinburg (Sverdlovsk)	55,488	134,356	143
21. Minsk	91,494	123,613	35
22. Orenburg	72,740	121,975	68
23. Novo-Nikolaevsk (Novo-Sibirsk)	5,000	120,611	2310
24. Voronezh	84,146	116,576	39
25. Yaroslav	70,610	112,103	59
26. Ivanovo-Voznesensk	53,949	111,114	106
27. Tver	53,477	105,714	98
28. Yusovka (Stalin)	32,000	105,706	230
29. Vladivostok	28,896	102,454	254
30. Samarkand	54,900	100,182	83

*For location see Figure 4.

population of the Empire would be somewhat lower than the 15 per cent but in any case higher than the official 13 per cent.

Since the year 1918 the thickly populated territory in the west, with a considerable part of its population town dwellers, has been separated from Russia. Moreover, immediately after the Revolution not a few townspeople deserted the towns for the villages. Yet it appears that the percentage of town dwellers is higher than it formerly was. This may be accounted for by the present federative organization of Russia, local autonomy requiring a considerably greater number of administrative centers. The newly formed or enlarged town centers attracted the town population back from the country and gave them

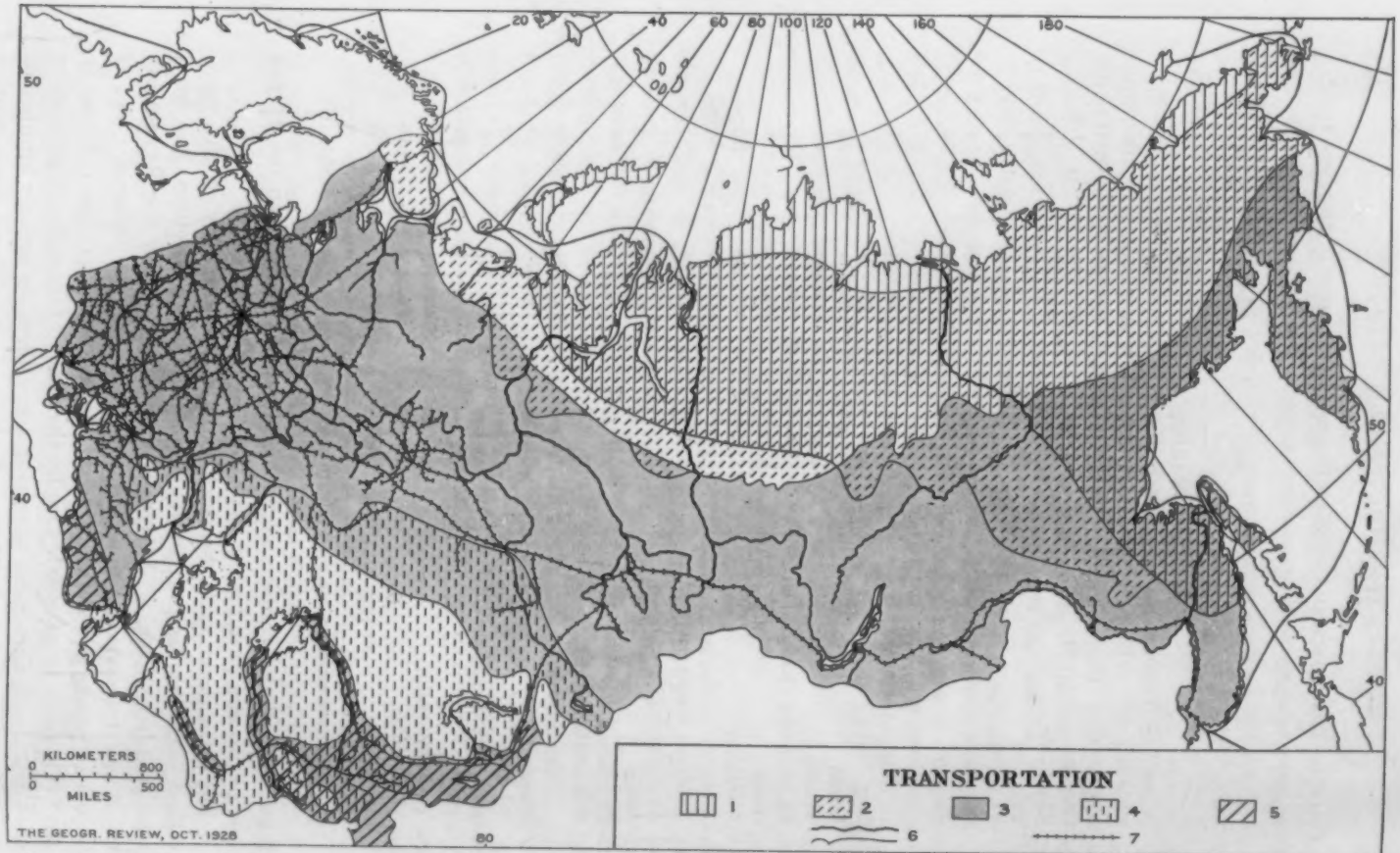

FIG. 10—Means of transportation, compiled by B. Semenov-Tian-Shansky. 1, dogs; 2, reindeer; 3, horses and oxen; 4, camels; 5, mules, asses, and buffaloes; 6, principal lines of navigation on rivers and seas; 7, railways.

work. Suburban settlements at the beginning of the Revolution were completely deserted and partly destroyed, but during the years 1923–1926 their population increased 39 per cent in consequence of the housing crisis. Workers' settlements increased by 38 per cent at the same time, and settlements along railways and waterways as well as industrial towns by 32 per cent. The mean growth of the population of all towns of the Union for that period was 24 per cent, or an increase of 6 per cent a year. The town population is greatest in the central region, with an offshoot towards Leningrad, and in the southern and the Ural regions (see Fig. 4).

Immediately after the October revolution of 1917 the population of Petersburg fell to 700,000, and a considerable number of the wooden houses on its outskirts were torn down and used as fuel. Now the population has again increased to over 1,600,000 and continues growing, but meanwhile the present capital Moscow has taken first rank. Kiev and Baku likewise have overtaken Odessa, which, owing to the decline of its commercial port since 1914, shows the smallest increase of all the large towns. The record in growth may be accorded to Novo-Nikolaevsk with 2310 per cent, which after the Revolution, under the name of Novo-Sibirsk, has become the principal administrative center of Siberia and its largest railway-and-waterways junction. It is situated on the Ob in the center of the black earth region north of the Altai plain, the most densely populated in all Siberia. As late as the year 1895 on the site now occupied by Novo-Nikolaevsk grew a pine forest with a forester's cottage where I chanced to spend a night. Since the census the rapid growth of the town continues, and in the neighborhood small wooden houses often spring up in the course of a single night. By its growth Novo-Nikolaevsk retards that of its neighbor, ancient Tomsk (92,485 in 1926), the geographical situation of which is less favorable, and has all but smothered another ancient town, Kolyvan on the Ob (8000). Next in rapidity of growth is Omsk, also a railway-and-waterways junction on the Irtysh. In eastern Siberia, which is more thinly populated, the growth of towns has not been so rapid; so far none has reached 100,000, though Irkutsk is not far short (98,979). On the Pacific, Vladivostok exceeds 100,000. Generally speaking the Siberian towns and those on the borders of the Union grow more rapidly than those of old Great Russia, as is the general rule in any colonizing process. Within European Russia Yuzovka, in the basin of the Donets, with its metallurgical works exhibits the most rapid growth.

Communications as Affecting Population Spread

The gradual occupation of the territory of the Soviet Union by Slavic agriculturists was accomplished when ways of communication

THE GEOGR. REVIEW, OCT. 1928

FIG. 10.—Means of transportation, compiled by B. Semenov-Tian-Shansky. 1, dogs; 2, reindeer; 3, horses and oxen; 4, camels; 5, mules, asses, and buffaloes; 6, principal lines of navigation on rivers and seas; 7, railways.

were very poor. Through a third of the territory transport is still effected by means of dogs and reindeer, through about one-sixth by camels, through about one-half by horses and oxen, and in quite an insignificant part of the southern territory by mules, asses, and buffaloes. On Western European maps, it may be remarked, the northern limit of the range of the ass in Russia is generally shown too far north, where it cannot endure the severity of the winter. A more or less considerable network of railways is developed only in the western part of the territory, within the range of the horse, while some two or three trunk lines provide for the needs of the remaining area. Rivers freeze over for a large part of the year throughout the greater extent of the Union, and little has been done towards connecting them by canal. The vast Siberian rivers inconveniently fall into the Arctic Ocean, a dead sea: and even the best water artery of the Union, the Volga, flows into a closed salt lake, called "sea" by courtesy. Communication by motor, owing to the bad state of the unmetalled roads, is feebly developed: according to official information the country possessed only 12,000 motor vehicles in 1927 (in 1928 the United States had over 23,000,000 motor vehicles). The colonization of these vast spaces therefore deserves the greater credit.

House Types

Slavonic colonization of the Eurasian continent, peculiar for its severe winters, has produced in the course of many centuries types of small but warm dwellings heated in winter with wood in the forest-clad north and with straw and dry dung in the southern treeless steppes. These dwellings are built of wood with shingle roofs in the north, of wood roofed with thatch in the center, of clay and earth, covered with thatch, reeds, or earth in the south. Transition from such types to those of Western Europe has been accomplished slowly and unwillingly, especially the transition to several-storied buildings, in which the heating problem is much more difficult. For this reason and because of the general poverty of the people the towns of the Union, except the largest, often possess a considerable number of rural buildings, creating an aspect very different from that of the towns of Western Europe.

Some Relationships between the Members of the Soviet Union

The Soviet Union encloses within its bounds vast spaces that are thinly inhabited by native trappers of the forest or steppe nomads, from whose mode of life native towns could never spring. But now, with the introduction of the autonomous federative organization, towns are needed even here. The only expedient for the local popu-

lation, therefore, was to utilize such Russian towns as already existed on the borders of their territories. These have been made into capitals, their names being changed according to the local taste. Thus the Zyrians made the small Russian border town of Ust-Sysolsk (8000 inhabitants) the capital of the republic, Komi; the Kirghiz in the republic Kazakstan did the same with the Russian border town of Perovsk (22,000), giving it the name of Kzil-Orda; the town of Vernyi (45,000) has had its name changed into Alma-Ata; the capital of the Bashkir republic is the large Russian town of Ufa (97,000), and so on. The Western European might be inclined to regard such facts as denoting decolonization, but in fact they are rather features of a novel peaceful symbiosis.

Similiarly, although no general compulsory official language has been declared, the international language within the limits of the Soviet Union and consequently the general language of the Union remains Russian. At the same time every one of the united republics and autonomous provinces uses its own state language for its own needs. As the greater number of these units hitherto had either no literary language or one little developed, an active manufacture of such languages is now in progress.

Great efforts are also being made to promote regional survey. The newly formed republics of Yakutia, Kazakstan, Bashkiria, Karelia, Buriatia have spontaneously requested the Federal Academy of Sciences in Leningrad to institute a thorough investigation of their territories and population by Russian scientists at their own expense. The Federal Geological Committee in Leningrad is exploring the mineral resources of all countries within the Union; the Central Statistical Administration in Moscow coöperates with the local statistical bodies of all the republics, amongst other functions conducting the federal census: this was accomplished by means of the local statistical institutions of the separate republics, returns being made in the local languages. The Planning Committee of the Federal State in Moscow projects economic measures for all the republics, as for example electrification, communications. Hence, and also because of the contrasted natural character of the federal republics constituting the Union, their relations are founded on the principle of mutual help in their economic life.

The human agglomeration of the 146 millions inhabiting the Soviet Union originated and has grown under difficult conditions, climatic, historical, and economic, and has always been distinguished by its lack of stable equilibrium. Yet it has always managed its internal affairs independently of foreign interference, and, as has been well pointed out by Woeikov, nowhere in the world but in Russia and China has internal trade played so important a part in the economic life of the country.

The Russian geographer Silinich has justly observed that before the World War imperialism in Russia was purely geographical, consisting in the search for natural physical boundaries, and not economic or national as was the case with other European states. Having acquired extreme mobility in sustaining so long a conflict with nomads, Russia in the course of time, when its interest clashed with those of other states, yielded territories which it had occupied with the ease that characterizes the nomad. Historically Russia has confined itself, according to the expression of our greatest poet Pushkin, "to cutting windows" looking out on the never freezing seas. But our people's chief energy has been spent colonizing the vast thinly populated country and struggling with its rigorous natural conditions.

Russia has always had and still has its own Eurasian interests which are neither purely European nor purely Asiatic. One of these interests was the pacification of the aborigines and reconciliation of the nomad tribes with the agriculturists. The problem has been solved successfully, and the former rivals have become friends; they have managed to draw boundaries between their territories so as not to hinder each other, and the nomads have gradually begun of their own free will to turn to the once hated occupation of husbandry whose tools they used in the old days to destroy, annihilating entire well irrigated districts.

The general trend of that colonization as here set forth is so worthy of respect as to call for general sympathy. If to this be added the heroic struggle with rigorous natural conditions, the feat performed by the eastern Slavic colonization stands out the more prominently in the history of humanity. It was not altruism that guided reconciliation with the savage aborigines but the extremely harsh natural conditions, which involuntarily unite people in their struggle against nature and lead them to mutual assistance.

THE POPULATION OF ANCIENT AMERICA

H. J. Spinden

Peabody Museum, Harvard University

[With separate map, Pl. VII, facing p. 660]

WHAT is the Indian population in America today, and is it increasing or decreasing? Was it as large in 1492 as it is now or as it had been in some earlier period of New World history? These questions I hope to answer not so much with statistics as with suggestive considerations. Indeed, exact figures are not available even for the proportion of Indian blood in the present population of America, and it is obvious that the speculative factor must become larger and larger as we pass back through the centuries.

Present Indian Population

The present Indian population in the New World is much larger than most persons might imagine from their knowledge of conditions north of Mexico. For Greenland, Canada, Alaska, and the United States the number is less than 400,000, with considerable admixture of foreign blood for which a proportional discount must be made. For the United States the most reliable count of Indians was the census of 1910, which found 265,683 individuals. Of this number 150,053 were full bloods, and the others mixed bloods with a distinct leaning towards white. The census of 1920 showed a reduction of 21,246 from the figures for the preceding decade. The counts made by the Bureau of Indian Affairs differ widely from those of the general census, since in some cases persons with one sixty-fourth part Indian blood are called Indians. Also the tribal rolls used by the Bureau, in spite of various purgings, carry a large number of negro "freedmen" who may or may not have old American blood. For 1920 the aboriginal population according to the Bureau was 336,379, or 91,942 in excess of the census of that year. Fluctuations, explained mainly by reorganization of the rolls, are apparent in the following totals for different years:

1870	313,712	1887	243,299
1877	276,540	1900	270,540
1885	344,064	1926	349,964

Probably the Indian strain in the United States, counting proportional values only, is equivalent to about 200,000 individuals of pure

blood, with claims of recent increase unjustified. The Navajo and one or two other tribes have more than held their own, but except for these a general decrease is indicated.

What a difference when we turn to Mexico! There the census of 1900 found a total of 13,605,819 inhabitants, classified as 19 per cent whites, 38 per cent Indian, and 43 per cent mixed bloods. The census of 1910 gave the total as 15,160,369, but by 1920 this had receded to 14,234,852, perhaps as a result of civil war and emigration. It is difficult even to estimate the proportion of Indian blood in the total population of Mexico, since classification is formed on the language basis. The statistical Indian is one who speaks an Indian language, generally to the exclusion of Spanish.

We have one excellent study of a special region, the Valley of Teotihuacán, which was made by the Department of Anthropology of the Mexican federal government.[1] The total population of the Valley of Teotihuacán is 8330, of which 6825 are of local origin, 1477 come from other districts of Mexico, 10 are foreigners, and 18 unclassified. In the matter of race 5657 are Indians, 2137 are mixed bloods, and 536 are whites. But of the total, 7860 speak Spanish; 448 both Indian and Spanish; while 7 speak only an aboriginal tongue. The proportion of Indian blood in this instance is almost 80 per cent; but whether or not this proportion would hold true of all Mexico is another question.

Indian community life and language are preserved in many regions of Mexico to a much greater extent than in the Valley of Teotihuacán. The statistics on native tongues are not reliable, but according to the census of 1900 they are spoken by 3,971,434 individuals. Playing safely within the estimates of several observers but remembering the high proportion of Indians who have lost their native speech, we conclude that the Indian blood in Mexico is equivalent to a pure population of at least 10,000,000 souls.[2]

Other Central American and South American countries where the Indian forms a very high percentage of the total population are Guatemala, Salvador, Honduras, Colombia, Ecuador, Peru, and Bolivia. Elsewhere the proportion is always considerable even in the cases of Argentina and Chile, which fail to make adequate return in their censuses of such Indian blood as does survive among accultured aborigines.

Always making allowance for mixed bloods at proportionate value, we summarize thus:

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[1] Manuel Gamio: La población del valle de Teotihuacán . . . 2 vols. in 3, Department of Anthropology, Mexico, 1922; Reference in Vol. 1, Pl. II and pp. xxii–xxiv. In the English summary, "Introduction, synthesis and conclusions of the work, The Population of the Valley of Teotihuacán" reference is Pl. III and pp. xxi–xxiii.

[2] If the "mixed race" classification of the Mexican census be taken as half Indian we have nearly 70 per cent for the total of Indian blood, but it is obviously more than half Indian.

North America north of Mexico	350,000
Mexico	10,000,000
Central America	2,500,000
Colombia and Venezuela	3,000,000
Ecuador, Peru, and Bolivia	6,000,000
Brazil, Paraguay, Uruguay, and Guianas	4,000,000
Argentina and Chile	200,000
West Indies	
	26,050,000

This gives a conservative minimum of 26,000,000 for the red race at the present time.[3] We now look into the past and consider the evidences of population, first at the coming of Europeans, and then on more ancient levels of the native civilizations.

The Depopulation of the West Indies

In the West Indies hardly a drop of the old American blood can now be found. Indeed, the Spaniards had scarcely set foot on the teeming islands before the native population melted away. Santo Domingo was colonized in 1493, Porto Rico and Jamaica in 1509, and Cuba in 1511. Las Casas in his famous "Brief Relation" says in regard to Porto Rico and Jamaica:[4] "Whereas there were more than three million souls, whom we saw in Hispaniola, there are today, not two hundred of the native population left." He was writing no later than 1542. Elsewhere Las Casas places the population of Porto Rico at 800,000 and that of Santo Domingo at 3,000,000. These are doubtless extravagant estimates. However, on the basis of personal surveys of many archeological sites in Porto Rico I postulate a population of at least 100,000. Santo Domingo, a much larger island, is archeologically almost unknown; but, since characteristic remains of the ancient Taino culture[5] extend from Porto Rico across Santo Domingo to the eastern end of Cuba, the total population of the Taino nation may easily have been a million. It is clear that Cuba, except for the region about Cape Maisi, was scantily peopled. Jamaica and the Lesser Antilles offer considerable evidence of ancient human habitation but not of a kind permitting even a rough estimate of numbers.

[3] Karl Sapper in "Die Zahl und die Volksdichte der indianischen Bevölkerung in Amerika von der Conquista und in der Gegenwart" (*Proc. 21st Internatl. Congr. of Americanists Held at The Hague, Aug. 12–16, 1924*, Part I, pp. 95–104) estimates the present (1910) Indian population of America at between 15 and 16 millions and that at the end of the fifteenth century at between 40 and 50 millions. The paper is summary in form and undocumented. Sir Harry Johnston in "The Negro in the New World" (1910) estimates at "20,855,000 hybrids between the white and the Amerindian" and "16,000,000 of pure-blood Amerindian and Eskimo" in the New World (p. 484.)

[4] F. A. MacNutt: Bartholomew de Las Casas, his Life, His Apostolate, and His Writings, New York, 1909, p. 316.

[5] J. W. Fewkes: The Aborigines of Porto Rico and Neighboring Islands, *25th Ann. Rept. Bur. of Amer. Ethnology, 1903–04*, Washington, 1907, pp. 3–296. M. R. Harrington: Cuba before Columbus, Part I, Vol. 1 (Indian Notes and Monographs, Misc. Ser., No. 17), Museum of the American Indian, Heye Foundation, New York, 1921.

Imported Diseases as a Factor in Depopulation

Even if we take Las Casas' estimates at one tenth their values, the eradication of the natives in a generation is difficult enough to explain. This could not have been accomplished by wholesale slaughter with the sword, considering the available forest cover and mountain retreats, but it might have been accomplished by epidemics of new diseases which searched out native villages far beyond the Spanish lines. Early mortality among the Indians is mentioned by Oviedo and other chroniclers. It seems that the so-called colonization of Santo Domingo was first of all a gold rush, with the natives suddenly exposed to a host of new diseases and to a condition of slavery under a heterogeneous and undisciplined mob. While starvation and these new diseases were probably the most active agents of sudden decrease in population, nevertheless the situation was commanded by a policy of frightfulness which caused a social collapse so complete that even the victors nearly perished of famine. The Spaniards gave no thought to planting crops, intent only on a fevered turning over of the ground in search of the yellow metal.

Devastating diseases pretty clearly of New World origin are syphilis and yellow fever.[6] To the first of these the agricultural Indians, especially those of Peru, Mexico, and the West Indies, had developed considerable immunity. Yellow fever was endemic in the Atlantic lowlands of Mexico and Central America, occasionally invading the highlands.

Europeans unloaded upon American Indians a tremendous burden of new infections for which the latter had not the slightest immunity. Perhaps smallpox comes first as an introduced plague and measles second, this latter malady being very deadly for the red man. But in the tropics the debilitation and mortality resulting from the introduction of malaria in three types and hookworm in two are heavy factors. There have been great epidemics of several other diseases, including Asiatic cholera. In recent years trachoma has been a burden among many tribes. High mortality among the aborigines has generally followed the opening up of new territories by the white men.

The small number of serious forms of disease in pre-Columbian America is explained first by the independence of New World civilizations. We must picture the tenuous connection between the hemispheres, consisting of nomads passing via Siberia and Alaska, as insufficient for the transmission of such pathological organisms as might already have attacked the thicker settlements of the Old World.

[6] Anthropologists have long insisted that syphilis was of New World origin, but the medical world after disputing the evidence is now accepting it. The case for the American origin of yellow fever is equally strong. This disease was implanted in Africa by slave traders, and some medical opinion now leans inconsistently to Africa as its cradle land (H. J. Spinden: Yellow Fever—First and Last, *World's Work*, Vol. 43, 1921, pp. 169–181).

Furthermore, few gregarious animals were brought under domestication in America to prove new sources of malevolent infection.

The Ten Plagues of New Spain

In Mexico the Spaniards struck sharply and deeply, while illusion of their divinity and magic power still obsessed the aboriginal populace. Nevertheless, they might easily have failed if reinforcements of invisible parasites had not come up in time. Between the retreat of Noche Triste and the final taking of Tenochtitlan smallpox fought most valiantly on the side of the invaders and finally turned the battle definitely in favor of Christianity.

Friar Toribio de Benevente, commonly called Motolinia, arrived at Vera Cruz in May, 1524, and his "History of the Indians

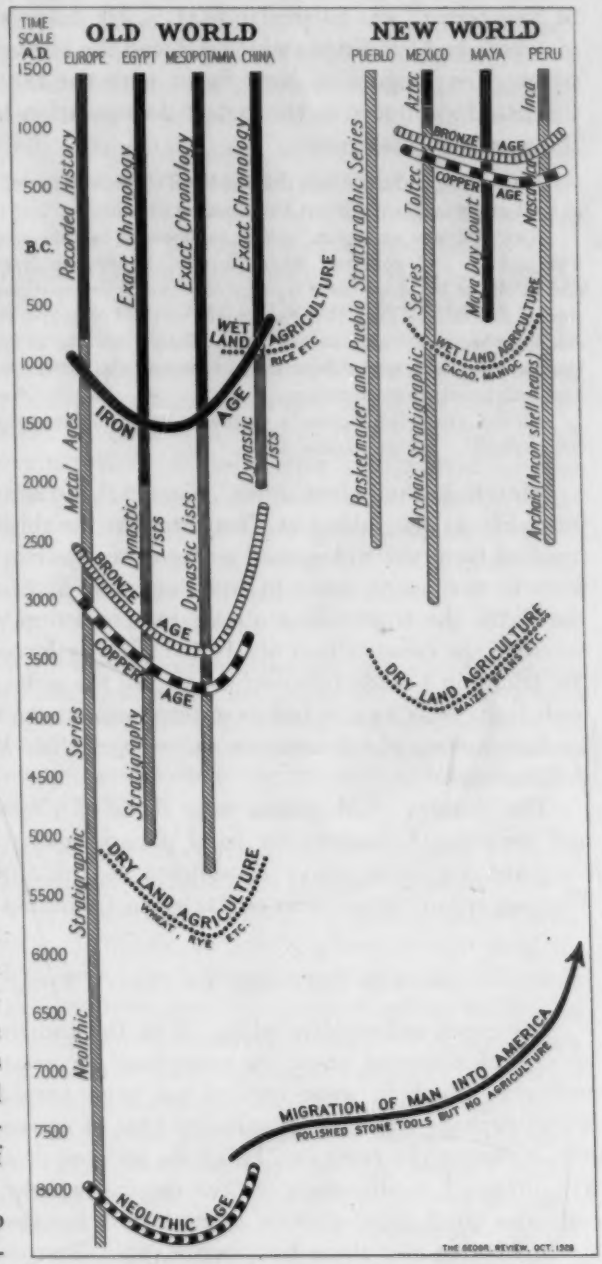


FIG. 1—Chronological and economic diagram of the parallelism between Old and New World civilizations which presents in summary form some of the facts bearing on the question of the population of ancient America. Note that the stratigraphic series of Europe is only carried back to the horizon of polished celts. Before this come the Mesolithic and Paleolithic series which are not represented in the New World.

of New Spain" was finished in 1541.[7] He draws a tremendous picture of events and conditions which reduced the native population by comparing Ten Plagues of New Spain with the biblical Ten Plagues of Egypt. I cannot give the gist of depopulation better than by using the words of this priest:

> God smote and chastized this land and those who found themselves in it, natives as well as strangers, with ten burdensome plagues.
>
> The first was smallpox, and it commenced in this manner. Hernando Cortes was captain and governor when Captain Panfilo de Narvaez disembarked here, and in one of his ships came a negro suffering from smallpox, a disease never before seen in this land. Then this New Spain was full of people to the extreme and as the smallpox began to catch among the Indians there was so great a malady and pestilence among them everywhere that in most of the provinces over half of the people died and in others scarcely less.
>
> Eleven years later came a Spaniard with measles which passed from him to the Indians . . . and many died.

Motolinia then gives other "plagues," the second being the heavy mortality at the taking of Tenochtitlan; the third, the famine which resulted from the widespread warfare; the fourth, the abuses of overseers in the towns given in vassalage; the fifth, the heavy tributes; the sixth, the tremendous abuses in connection with the mines; the seventh, the construction of Mexico City by forced labor; the eighth, the traffic in branded slaves; the ninth, the abuses of transportation with Indians as human beasts of burden; and the tenth, the factional warfare among the Spaniards themselves with Indians bearing the brunt of fighting.

The charges of Motolinia were those of a contemporary witness, and they are borne out by legal papers against Cortes, Alvarado, etc., and by such native documents as the Codex Kingsborough. The juggernaut drama was reënacted in Colombia and Peru.

On the Recovery of Indian Populations

The great and sudden falling off in the Indian population during epochs of conquest must be considered in relation to increase or recovery, which in some regions has been notable. In the United States perhaps the most remarkable case of increase over early numbers is that of the Navajo. This tribe secured sheep, became pastoral without much modification of their original wandering life, and in two centuries quadrupled without admixture of foreign blood.

In Mexico also there has been a rapid increase from low records of the Spanish régime, as may be seen by comparing the figures col-

[7] (Fray) Toribio de Benavente o Motolinía: Historia de los Indios de la Nueva España, Barcelona, 1914; pp. 13–14. For another important reference on depopulation see Juan López de Velasco: Geografía y descripción universal de las Indias: Recopilada por el cosmógrafo-cronista Juan López de Velasco desde el año de 1571 al de 1574, publicada por el primera vez en el Boletín de la Sociedad Geográfica de Madrid, con adiciones é illustraciones, por Don Justo Zaragoza, Madrid, 1894, p. 26.

lected by Humboldt[8] with those of today. For 1803 the German traveler makes the population of Mexico 5,837,100; classified as 18 per cent white, 60 per cent Indian, and 22 per cent mixed. The area covered is not exactly the same as that of today; but the state of Chiapas, then counted with Guatemala, serves to counterbalance parts of the Southwest which now belong to the United States. The increase is about 150 per cent in 125 years, and the Indian part of the population seems to hold its own proportionally or perhaps to gain if we eliminate immigrants. The Maya territory in the peninsula of Yucatan is an exception to the general advance. Humboldt gives the population of the political district of Mérida (which seems to have included Campeche) as 465,800 and that of Valladolid as 476,400, making a total of 942,200 for the Mexican proportion of the peninsula.[9] This may have been an overestimate, but a very great falling off resulted from the terrible War of the Castes precipitated by the sending of several shiploads of Maya Indians to Cuba as slaves. This war broke out in 1848 and resulted in abandonment by white landowners of much of eastern and central Yucatan. Parts afterwards pacified were never able to retrieve the earlier prosperity.

Of Guatemala in 1778 Juarros[10] says:

> The larger and principal part of these lands was captured by Captain D. Pedro de Alvarado in the year 1524 and following. In that time these countries were much more populated than at present since according to the count made by order of His Majesty in the year 1778 this kingdom has no more than 797,214 inhabitants; while in the time of its conquest its inhabitants were innumerable, so much so that they comprised more than 30 nations.

But the Guatemala of Juarros covered all the territory between Mexico and Panama and even included the present Mexican state of Chiapas. Now this area supports about 6,000,000 inhabitants. While part of this total is covered by immigration, a very great increase is generally to be noted for Indians living agricultural lives in open country. I have elsewhere given the present Indian population of Central America in round numbers as 2,500,000. A missionary living on the populous Guatemalan highlands estimates that there are at present 750,000 Indians speaking native languages and maintaining parts, at least, of the ancient culture. These are ranked as peons; and some 300,000 of them are compelled to migrate to the unhealthy coffee regions of the coast for part of the year—a necessity which has resulted in heavy mortality. Others serve as burden-bearers to escape the classification of forced labor. It is possible to

[8] Essai politique sur le royaume de la Nouvelle-Espagne (Voyage de Humboldt et Bonpland, Part III), 2 vols. and atlas, Paris, 1811; reference in Vol. I, pp. 152 et seq.

[9] *Ibid.*, p. 155.

[10] Domingo Juarros: Compendio de la historia de la ciudad de Guatemala (2 vols., Guatemala 1808–18), Vol. 1, p. 8; English transl. by J. Baily: A Statistical and Commercial History of the Kingdom of Guatemala in Spanish America, London, 1823, p. 10.

demonstrate from the detailed statistics in the surveys of Velasco, Juarros, etc. that the Central American Indians have remarkable vitality in recovering population losses.

We need not follow much farther the statistical record of recovery of Indian populations from the lows reached after the incoming of Europeans. The Indian survival in the West Indies is negligible,[11] but it happens that about 5000 so-called black Caribs, former residents of St. Vincent, were dumped in 1793 on the then deserted island of Ruatan by the English for trafficking with the French. They were strongly intermixed with negroes, and today their descendants might be taken for negroes were it not that they talk and live like Caribs. This people now number about 30,000 souls; and their villages stretch from Stann Creek, British Honduras, to Carib Town, Nicaragua.

Evidences of recovery must be taken in conjunction with other evidences of continuing decrease. For instance, the Xicaque, Paya, Sumo, Guatuso, etc. in Central America are fast approaching extinction, and the same holds true of natives of the Putumayo in Colombia who are now concentrated in missions. Similar concentrations in California, Central America, Bolivia, Paraguay, and Chile long since led to complete extinction of many tribes. In Brazil the aborigines suffered heavily in the recent rubber trade, while in Tierra del Fuego sheepmen went so far as to put a bounty on their heads. It seems that sporadic increase still falls short of restoring the Indian population at the advent of the whites. But another matter awaits discussion, namely, crests of population in pre-Columbian times.

Population Peaks under Indian Civilization

The highest civilization of the New World was that of the Mayas, whose great and numerous ruins of stone and mortar exist in a region of rain forests now practically uninhabited. Here we are dealing with a people who invented writing and mathematics in addition to architecture and who left dated records of their achievements on stone monuments which enable us to restore the chronological framework of history. It now appears certain that the Mayas were living in the humid lands at least as early as 613 B. C., when their day count was inaugurated.[12] This means that several arid-land plants, including maize and beans, had already been adjusted to wet conditions. The earliest "contemporary" date found (on the Tuxtla statuette) is 98 B. C., and the peak of the urban civilization of what is called the First Empire falls between 300 and 600 A. D.

[11] Culin describes a settlement in eastern Cuba which still contains a little Indian blood (Stewart Culin: The Indians of Cuba, *Bull. Univ. of Pennsylvania Free Museum of Sci. and Art*, Vol. 3, 1902, pp. 185–226).

[12] H. J. Spinden: The Reduction of Mayan Dates, *Papers Peabody Museum of Amer. Archaeology and Ethnology, Harvard University*, Vol. 6, No. 4, Cambridge, Mass., 1924.

But by 630 A. D. every one of the great cities had been abandoned. This abandonment may have begun about the middle of the sixth century of our era, judging from the latest dates at several cities. Speculation has been rife concerning its causes. Huntington[13] has developed a theory of climatic change, which does not seem to meet the known facts; and Cook has argued that the Central American savanas are exhausted agricultural lands.[14] But the barren savanas respond to geological conditions without evidence of having been farmed. Moreover, the dates show that cities located on the rich flood plain of the Usumacinta were abandoned at the same time as cities on the shallow-soiled plain of Petén. Warfare does not seem to have been highly developed, for none of the early Maya cities are fortified. Sanitation affords the best explanation, and it happens that yellow fever had its most likely place of origin in Central America.[15]

FIG. 2—Distribution of agriculture in the New World in pre-Columbian times. Numbers have reference to agriculture: 1, in arid regions of considerable altitude, mostly with irrigation; 2, under humid lowland conditions; 3, under temperate conditions.

Yucatan and in fact the whole area of the Mayas is a welter of hewn stone and rubble constructions of the most massive character. Yet during the prolific First Empire the Mayas were entirely unacquainted with metals. We must picture them cutting and carving stone with stone tools and carrying the material on their backs or dragging it over the ground from quarry to structure. It is an astonishing fact that there

[13] Ellsworth Huntington: The Climatic Factor as Illustrated in Arid America, *Carnegie Instn. Publ. No. 192*, Washington, 1914.

[14] Discussed by S. G. Morley in "The Inscriptions at Copan," *Carnegie Instn. Publ. No. 219*, Washington, 1920, pp. 452–457.

[15] The Books of Chilam Balam, Maya chronicles, record pre-Spanish visitations of yellow fever under the name xekik, "blood vomit."

is no evidence of the mechanical use of the wheel in connection with traction anywhere in the New World on any cultural level. Human labor of the most strenuous sort was called for, and the vast accumulations have therefore an important bearing on population. Another fact that has often been overlooked is that the Mayas, lacking the help of draft animals, were also spared the expense. They were not forced to divide their supply of vegetable food or the land available for cultivation with hungry brutes far less economical than human beings.

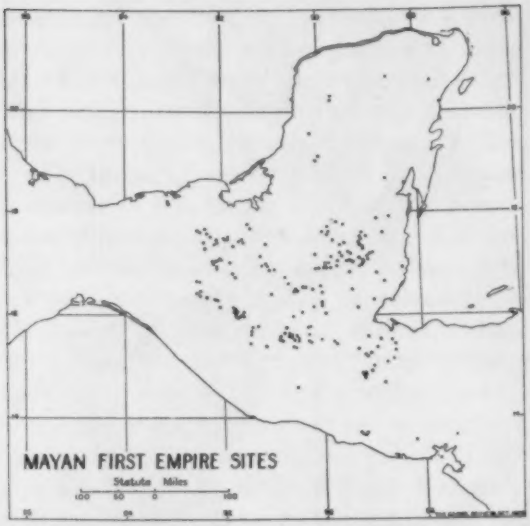


FIG. 3—Map showing sites of ruins of the First Mayan Empire. Scale, 1:16,000,000.

I have elsewhere presented the theory that American agriculture was distributed on two distinct planes corresponding to economic development, first, of the arid lands and secondly, of wet lands, both in tropical regions, and that temperate moist-land development was dependent upon the second plane of distribution.[16] In general this follows Harshberger's botanical evidence on the dissemination of maize.[17] In Mexico and Central America there is a safe priority of several thousand years for arid-land agriculture, and some of the plants domesticated under the régime of irrigation spread to the very limits of the New World agricultural area. The staple plants were modified to meet humid conditions probably under the stimulus of a pressure of population on food supply which induced farmers to invade the wet forests. On the other hand, the new plants domesticated in humid habitats had only a restricted distribution and were never developed to meet dry conditions; witness cacao, manioc, and pineapples. Perhaps the most widely distributed plants of the wet lands were sweet potatoes and peanuts, both capable of being grown in temperate regions.

It appears that the dry-land culture of Mexico and Central America, traced by the vestiges of Archaic art, spread first of all

[16] H. J. Spinden: The Origin and Distribution of Agriculture in America, *Proc. 19th Internatl. Congr. of Americanists, Held at Washington, Dec. 27–31, 1915*, Washington, 1917, pp. 269–276.

[17] J. W. Harshberger: Maize: A Botanical and Economic Study, *Contribs. from the Botan. Laboratory of the Univ. of Pennsylvania*, Vol. 1, No. 2, Philadelphia, 1893.

through arid lands into our southwestern states and into western and northern parts of South America. Then the adaptation to the forest zone in the Mayan area took place, and the great economic success of this led to the conquest of forest areas elsewhere in Mexico and Central America, parts of South America, and the West Indies. We know from their calendar, etc., that the Mayas were established in rainy regions as early as the seventh century before Christ. If we grant an original seed population of 8000, a peak of 8,000,000 is found after ten doublings. This is not excessive for 1200 years of undisturbed social evolution, and indeed it appears that the strongly urban conditions of the sixth century of our era demand an even greater number. From the archeological evidence the region of the First Empire appears to have been one of the most densely peopled parts of the world.

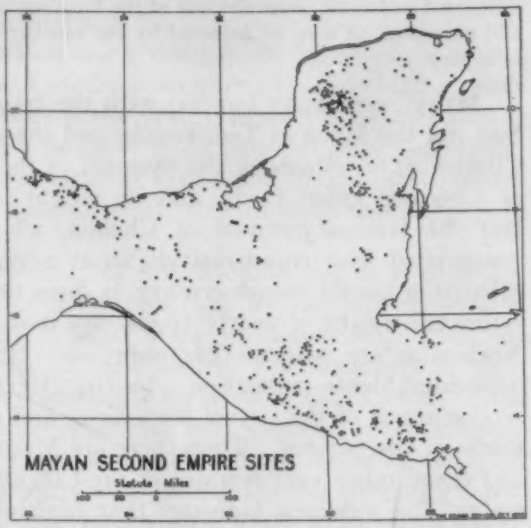


FIG. 4—Map showing sites of ruins of the Second Mayan Empire with the high development in northern Yucatan.

THE TOLTEC PEAK

The Mayan First Empire suddenly crumbled; and, considering the involved urban life in a far from friendly habitat we must imagine that this collapse resulted in tremendous mortality. Ranks of society were re-formed, however, and a second minor peak was reached in the much drier region of northern Yucatan about 1200 A. D., coinciding with the activities of the Toltec kings who conquered Chichen Itza in 1191 A. D. At this time on the highlands of Mexico a strong urbanization movement was taking place. It seems to have begun among peoples near the Mayas, namely the Olmeca, the Zapoteca, the Totonacs, etc., who lived in rather wet territory of southern and eastern Mexico, and among the Chorotega on the Caribbean coast lands to the south. But the Toltecs of the Valley of Mexico got the upper hand and under Huetzin, Ihuitemalli, and Quetzalcoatl formed a great empire of trade and tribute over the sedentary nations as far south as Nicaragua. The stimulus to population on the highlands of Mexico—doubtless high and fairly stable for many centuries—

came from imported food. We have seen that the Valley of Teotihuacán has a population of 8330. Gamio says as regards its ancient population:[18]

> The extension and importance of pre-Spanish settlements in this region, vestiges of which still exist, allow us to estimate their total population to have been ten or twenty times as great as the present one, and possibly even greater . . . There is no doubt that the definite downfall of the Teotihuacán civilization was the cause of numerous migrations from the valley; yet centuries later, when the region was conquered and came under the rule of the kingdom of Tezcuco, the population was still numerous, as may be gathered by the number of tributary settlements cited in history.

Many persons are familiar with the tremendous pyramids of the Sun and the Moon at Teotihuacán and the great structure called the Citadel. The volume of the pyramid of the Sun has been estimated at 1,290,000 cubic yards, and its weight at about 3,000,000 tons. But the famous pyramid of Cholula, which seems to have been constructed in a comparatively short period by disciples of Quetzalcoatl in the thirteenth century, is three times as large, with a total estimated weight of nearly 10,000,000 tons. The vast terracings of Xochicalco are scarcely less impressive evidence of human labor demanding dense population. In 1927 I explored a scantily peopled section south of the city of Vera Cruz and found tremendous earthworks of the Olmeca. Then there are Monte Alban of the Zapoteca and many other vast remains of pre-Columbian Mexico and Guatemala. The evidence indicates that population on the Toltec level (1000–1200 A. D.) was much greater than when Cortes arrived in 1519 A. D. The Toltec Empire collapsed in the second decade of the thirteenth century with civil war, starvation, and disease as the designated causes.

Ancient Indian Population North of Mexico

Estimates of the ancient Indian population for the area of the United States and Canada have not been based on archeological evidence so much as on indications during some early stage of European contact. A most complete study of this area by James Mooney has recently been published as a posthumous work.[19] The total number of Indians for America north of Mexico at the advent of the whites is here estimated at 1,150,000, divided as follows: United States 846,000; Canada 220,000; Alaska 72,000; and Greenland 10,000.

Mooney's figures seem overconservative for a large part of the United States, and yet they are lowered in detail by several writers on special fields. The densest settlement existed in California and

[18] Gamio: *op. cit.*

[19] The Aboriginal Population of America North of Mexico, *Smithsonian Instn. Publ. 2953*, Washington, 1928.

along the Pacific coast as far north as Alaska. All the tribes of this area were on a pre-agricultural plane of life which was not widely nomadic, thanks to a fair food supply consisting of acorns, various wild root crops, and salmon. That these pre-agricultural people should have established themselves in much greater density than the central and eastern Indians of the United States who possessed agriculture seems inexplicable unless, as we surmise, the western population was near its crest when whites arrived while the central and eastern population was already depleted.

Mooney's total for California is 260,000 souls, following the figures of C. Hart Merriam based on mission statistics. Kroeber[20] reduces the population of the state for the year 1770 to 133,000. Today it is only 15,000, indicating a decrease of 89 per cent from the smaller estimate. Even if we accept Kroeber's reduction the density of Indian population in California remains nearly four times that of the rest of the United States.

The non-agricultural Indians of America have had more difficulty meeting the competition of the whites than the agricultural Indians except those bearing the full brunt of early colonization. Their old food supply has been cut off, and violent readjustments in their mode of life have been accompanied by a rising death rate. Along the Pacific coast the salmon runs have been depleted by commercial fisheries; elsewhere wild game has been killed off, including the great herds of buffalo on the Plains; while on the Plateau natural gardens of camas and other edible roots have yielded to the white man's wheat-fields. Besides suffering these economic losses the non-agricultural Indians in general have been more warlike, or at least more given to resisting injustice, and have invoked their own extermination. In the case of California many tribes fell under missionary control: among these the percentage of survival is very low. Indian mortality in Oregon, Washington, and Idaho has also greatly exceeded the birth rate since the advent of the whites, the population figures for 1780 being 89,300 and for 1907 only 15,431. British Columbia and southern Alaska show nearly as bad a record.

These non-agricultural western summaries will now be contrasted with eastern agricultural ones for tribes distributed in a continuous area from the Great Lakes to the Gulf of Mexico and from the Atlantic to considerably beyond the Mississippi and well up the Missouri. The purely nomadic buffalo-hunting tribes of the Great Plains are marginal and are eliminated from the tabulation as well as all Canadian tribes except the few that practiced agriculture. The dates at the left in the following table give the eras at which Mooney calculates the population.

[20] A. L. Kroeber: Handbook of the Indians of California, *Bur. Amer. Ethnology Bull. 78*, Washington, 1925, pp. 880–891.

1600	New England, New York, New Jersey, and Pennsylvania .	55,600
1600	Maryland, Delaware, the Virginias, and the Carolinas . .	52,200
1650	Georgia, Alabama, Tennessee, Florida, Mississippi, most of Louisiana, and part of Arkansas*	114,400
1650	Agricultural tribes of the Central States**	40,300
1696	Agricultural tribes of the Southern Plains	12,900
1780	Agricultural tribes of the Northern Plains	38,000
1600	Agricultural tribes of southern Canada	35,300
		348,700

* Swanton, who edits Mooney's work, reduces these figures by about 18,000 mostly on estimates of the Creek and Chickasaw.

** I exclude the Ojibwa as non-agricultural until recent times. Some of the other tribes are only partly agricultural.

This eastern agricultural area covers about 1,375,000 square miles of territory, and the figures of Mooney give one person to four square miles. Today this same area, resting heavily in the matter of food on Indian plants,[21] supports a population of something like 90,000,000 individuals.

The Problem of the Mounds

Now the mute evidence of the mound culture existing in the central part of this eastern agricultural area attests rather dense population over a considerable interval of time. Mooney's data show that at the epoch of white settlement Ohio[22] and West Virginia were practically deserted and that the region of the mounds had in general a scantier population than the surrounding territory. Contrary to early theory it has now been demonstrated that the mounds were built by the ancestors of existing tribes and that some of them are of no great age, since they contain objects of European manufacture. What is the answer to this riddle? I believe that the conditions can best be explained on the theory that diseases of European origin introduced by fleeing natives from the West Indies or by Spanish explorers, such as Ponce de Leon, swept up through the mound area several generations before the establishment of the English and French colonies. But the culture of the mound builders was already decadent, and its peak must doubtless be placed several centuries before Columbus.

Shetrone[23] says of ancient Ohio:

> Perhaps no equal area in the world contains so many prehistoric earthworks as the territory comprised within the state of Ohio. The . . . recently published Archeological Atlas of Ohio locates a total of 5396 prehistoric sites of the various classes. Of these, 3513 are mounds proper, 587 enclosures and fortifications,

[21] About four-sevenths of the agricultural production of the United States (farm values) are in economic plants domesticated by the American Indian and taken over by the white man.

[22] The Erie nation had been destroyed in 1656 by the Iroquois, and after that for half a century Ohio was uninhabited.

[23] H. C. Shetrone: The Indian in Ohio, *Ohio Archaeol. and Hist. Quart.*, Vol. 27, 1918, pp. 274–510; reference on pp. 467–468.

354 village sites, 39 cemeteries, 5 effigy mounds, 17 petroglyphs or pictured rocks, and 35 rock shelters or shelter caves. Besides these, 190 flint quarries and many individual burials, some graves, and other sites are located.

Some of the mounds are of large size, and their construction represents much labor. The largest mound of all is that at Cahokia opposite St. Louis, but the De Soto mound in Arkansas and the Etawah mound in Georgia are impressive constructions. The Cahokia mound is 1080 feet long, 710 feet wide, and 100 feet high, and covers 16 acres. The volume has been calculated at 21,690,000 cubic feet. But it is only one out of many manifestations of high population in a restricted district.

In Mooney's estimate we are asked to believe that only about 150,000 Indians dwelt in the mound area at the advent of the whites. This may be true if the advent is placed at 1610 A. D. instead of 1492 A. D. Also the abundant remains have been explained by imagining a small population existing for a very long time. But evidences of art and the law of population increase do not justify such dilation. It is at least seen that the concept of mounds for temple foundations cannot live when generations after generations are called upon to build the substructure of the temple. Rather it seems that the eastern agricultural area must once have supported several millions and that a halcyon period a century or two before the arrival of Columbus was ended by war and the pressure of wild tribes.

The Case of Pecos

In the Pueblo area abundant evidence points to an ancient régime of agriculture following an introduction of maize, beans, etc. from Mexico on the culture levels known as Basket Makers II and III. Strangely enough the earliest finds come from a small region far removed from the Mexican border,[24] while on the following culture levels called Pueblo I and II the geographical expansion of small-town remains reaches its greatest extent towards the northwest. Pueblo III is the time level of large towns formed by consolidations of small ones, and there is a withdrawal from the northwest towards the south, without, however, any great change in the total area covered. In this brilliant period the population of the Southwest reached its maximum, and trade with Mexico was developed. The Pueblo outposts were then in the state of Chihuahua, and the Toltec outposts were close by in Durango. Pueblo art and ceremony gained new elements from their Mexican correspondents. This vitalizing contact doubtless ceased with the fall of the Toltec empire in 1220, and it is a remarkable fact that a collapse in the Southwest closely paralleled

[24] See, for example, A. V. Kidder: An Introduction to the Study of Southwestern Archeology, Published for the Dept. of Archaeology, Phillips Academy, Andover, Mass. *Papers of the Southwestern Expedition, No. 1*, New Haven, 1924.

the collapse in Mexico. In part this must be explained by the raiding activity of nomadic tribes; but, whatever the causes, the area occupied by the village Indians shrank suddenly to about the present meager limits. There must have been a sharp decrease in numbers over the total area of the Southwest, and this decrease seems to have continued till comparatively recent times. At least many villages have been abandoned, and two languages, the Tano and Piro, have become extinct.

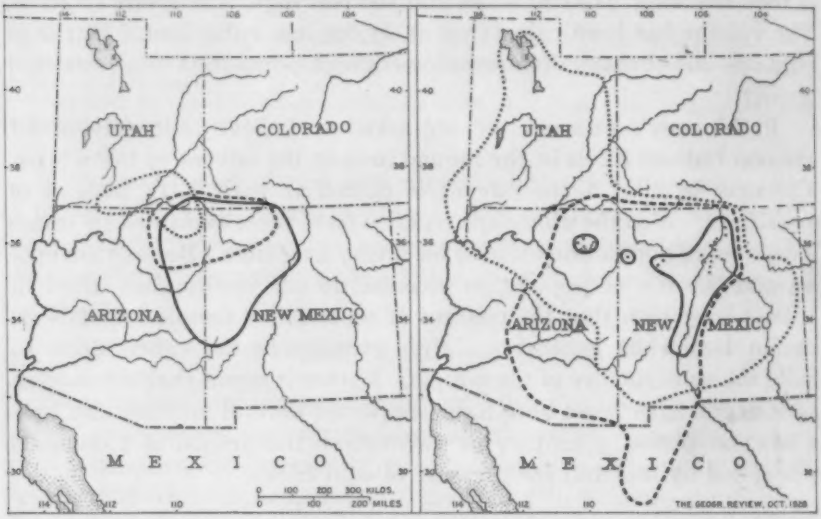


FIG. 5—Development of Pueblo culture. The left-hand map shows the nucleus of Pueblo culture: dotted line, region of Basket Maker II; dashed line, Basket Maker III; solid line, Pueblo I. The right-hand map shows the expansion and contraction of Pueblo culture: dotted line, Pueblo II; dashed line, Pueblo III; solid line, region occupied at the conquest; modern Pueblos are shown by dots.

A population curve for the pueblo of Pecos has been constructed by E. A. Hooton on the basis of burials associated with pottery, which reaches a peak at about 5000.[25] In general the results obtained are in agreement with the archeological evidence in the number of rooms occupied at different times. We seem to have here a population curve in which the rise is explained by social and economic efficiencies and the fall by decreasing agricultural returns, by disease introduced by Europeans, and lastly by savage warfare intensified after the horse had made long raids possible.

South American Arid-Land Civilization

In South America the agricultural civilizations are more ancient in the arid and open regions of Colombia, Ecuador, Peru, etc. than in the wet forested regions of the Guianas and Brazil; but fluctuations and displacements of population are more marked in the wet country for reasons that are not far to seek.

[25] Manuscript on Skeletal Remains at Pecos, to be published in the same series as reference 24.

The earlier series of Central American economic plants must have reached Peru during the Archaic period a thousand years or more before the time of Christ. Under the fairly stable but inelastic conditions of desert-land farming a practical balance between population and food supply may well have been reached on the basis of these plants and maintained with little change for many centuries. One frequently hears the opinion expressed that the agricultural terraces, or *andenes*, of Peru indicate a greater population in the past than now exists. But these terraces are still used in rotation; and, while impressive monuments for conservation, they do not, in fact, retrieve much acreage.

There was on the Peruvian highlands a great use of the indigenous potato, which may have been gathered anciently as a wild root crop. It is an important question whether the Andean tuber actually antedates maize, beans, and squashes in Peruvian cultivation: probably not, however, since the shell heaps of Ancon,[26] quite outside the natural habitat of the potato, nevertheless yield evidences of sedentary agricultural life earlier than proto-Nascan remains, likewise near the coast; and these in turn antedate the classical remains at Tiahuanaco on the plateau. The use of the potato extended from Chile into western Venezuela along the Andean ridges.

In spite of various shiftings in the centers of empire[27] the population of Peru seems to have maintained itself without cataclysmic breaks before the coming of the Spaniards. There were, to be sure, certain peaks of artistry which may or may not correspond to peaks of population. It is my opinion that extensions of civilizing influences from Central into South America will be found to correspond roughly with the Maya and Toltec culture crests, i. e. 400–600 A. D. and 1000–1200 A. D. The evidence of these streams of influence is seen more clearly in the wet-land cultures than the dry but may be noted in the art of Chavin and Recuay and more fully still at Puruhá in Ecuador.[28]

There is no reason to believe that the rapid growth of Inca power entailed great wastage of life. Indeed, the improved economic condition which followed the building of roads and the opening up of new provinces may actually have brought about an increase in

[26] Max Uhle: Die Muschelhügel von Ancon, Peru, *Proc. 18th Internatl. Congr. of Americanists Held at London, 1912*, London, 1913, pp. 22–45.

[27] See for instance P. A. Means: An Outline of the Culture-Sequence in the Andean Area, *Proc. 19th Internatl. Congr. of Americanists Held at Washington, Dec. 27–31, 1915*, Washington, 1917, pp. 236–252.

J. C. Tello: Introducción a la historia antigua del Peru, Lima, 1922 and various papers in *Inca*, Lima, 1923—.

Stratigraphic and stylistic studies are among papers by A. L. Kroeber, W. D. Strong, Max Uhle, and A. H. Gayton in *Univ. of California Publs. in Amer. Archaeol. and Ethnol.*, Vol. 21, Nos. 1–8, 1924–1927, and see also the paper on The Uhle Pottery Collection from Nasca by A. H. Gayton and A. L. Kroeber, *ibid.*, Vol. 24, No. 1, 1927.

[28] Jacinto Jijón y Caamaño: Puruhá, *Bol. Acad. Nacl. de Hist.* Quito, Vol. 3, 1922, and succeeding volumes.

numbers, at least making it easier to relieve famines. One thing is evident enough: the Peruvian conquests were made in regions where sedentary agricultural life had long since been established. Archeological stratifications in Ecuador[29] on the one hand and in Argentina[30] on the other prove this.

Perhaps density of population in the region covered by the Peruvian empire reached its apogee under Huayna Capac, the eleventh Inca (1470–1525). But the arrival of Pizarro in 1532, in conjunction with the fratricidal triumph of Atahualpa, was a stroke of doom. There was surely a tremendous falling off among the Indians of Peru after the Spanish occupation—the dire result of repressive measures, slavery, starvation, and disease. The adjudication of numbers for an era of 1525, when the eleventh Inca died without knowledge of the coming collapse of his great empire, cannot be made now; but it is not impossible that in many regions of Peru, Bolivia, and Ecuador the Indian has about retrieved his former situation as regards numbers.

South American Centers of Wet-Land Culture

These general observations on the stability of arid-land civilizations do not hold true of certain rather brilliant but restricted cultures of Colombia and Ecuador which flourished in humid lands and which had pretty clearly fallen into decay before the arrival of European marauders; nor do they hold true of ancient centers of wet-land civilization in Venezuela and Brazil, located farther to the east. In Colombia and Ecuador I refer more especially to the Zenu, who occupied territory east of the Gulf of Uruba; to the Quimbaya[31], who held the middle valley of the Cauca; to the nameless people who built the stone monuments of San Augustin[32] on the headwaters of the Magdalena; and to other tribes, whose very designations are doubtful but who once ruled the Pacific coast of Colombia and Ecuador from Choco to Manta. An outlying contemporary center was that of the Tairona on the flanks of the Santa Marta Mountains in eastern Colombia, recently described by Mason.[33]

These form an interesting chain of localities where the humid

[29] Jijón y Caamaño, *op. cit.*

[30] Éric Boman: Los ensayos de establecer una cronología prehispánica en la región Diaguita (República Argentina), *Bol. Acad. Nacl. de Hist.*, Quito, Vol. 6, 1923, pp. 1–27.

[31] Ernesto Restrepo Tirado: Los Quimbayas, a décimo octavo Congreso Internacional de Americanistas que se reunira en Londres en Mayo de 1912, Edicion oficial, 66 pp., Bogota, 1912.

Eduard Seler: Die Quimbaya und ihre Nachbarn, *Gesammelte Abhandl.*, Berlin, Vol. 5, 1915, pp. 63–76. From *Globus*, Vol. 64, 1893, pp. 242–248.

[32] K. T. Preuss: Bericht über meine archäologischen und ethnologischen Forschungsreisen in Kolumbien, *Zeitschr. für Ethnologie*, Vol. 52–53, 1920–21, pp. 89–128. "Ausgrabungen in der Gegend von San Agustin" covers pp. 91–105.

Idem: Die Ausstrahlungen der San Agustin-Kultur in Amerika, *Zeitschr. für Ethnologie*, Vol. 59, 1927, pp. 111–112.

[33] J. Alden Mason: Archeological Researches in the Region of Santa Marta, Colombia, *Compte-Rendu Congrès Internatl. des Américanistes, 21st Session, 2nd Part, at Göteborg, 1924*, Göteborg Museum, 1925, pp. 159–166.

tropics were temporarily conquered after the manner of the Mayas. The economic and social interrelations of these localities are found on the historical levels of Mayan and especially Chorotegan developments, or safely within the Christian era. The special contribution of these South American states was in metal working according to a technique which was afterwards imitated in Mexico: namely, a kind of filigree jewelry made by the lost wax process. Since no examples of this jewelry or any other objects of metal occur at the First Empire site of the Mayas while numerous specimens, some being clearly of Colombian manufacture, are found in northern Yucatan in deposits of about 1200 A. D., the conclusion is that the characteristic art of the southern centers flourished broadly from 500 to 1300 A. D. with activity in trading during the last two or three centuries of this period.

In addition to metal work there are other important intercontinental changes in technology and design, regarding which space does not permit elaboration. But the important bearing of these archeological indications is on the question of ancient population of the wet tropics below the intensively developed Mayan territory. For, if civilization had a long time to run in such environment, it must surely have resulted in dense settlements.

The best evidence that civilization did have a fairly long life in certain parts of humid South America is seen from the fact that a high culture existed about the mouth of the Amazon which had disappeared before the arrival of the whites. The archeological bond between Central America, Venezuela, and the lower Amazonas is first found on the Archaic level corresponding to an early distribution of the maize complex.[34] But eastern Brazil became the center of new agricultural developments. Manioc, sweet potatoes, pineapples, etc. seem to have been domesticated here and distributed towards the west. The high culture attributed to the Arawack and Tupi tribes was broken down by the raiding Caribs, and the beginning of the West Indian occupation may correspond roughly with the end of the Amazonian civilization. Some of the tribes moved out over the Antilles, and others pushed down along the coast of Brazil. But there are other evidences that the Amazonian use of jade and several religious concepts displayed in art must be placed at the earliest about 1000 A. D. This leaves, however, a long enough interval after the introduction of agriculture on the Archaic horizon to account for high populations.

Conclusions

1. The present equivalent of the Indian blood in the New World is in excess of 25,000,000 individuals.

[34] Female fetishes of fertility reach from Mexico to the island of Marajo in the mouth of the Amazon. For a brief presentation of the evidence see my "Ancient Civilizations of Mexico and Central America," published as a handbook by the American Museum of Natural History, 3rd edition, 1928.

2. There are fewer Indians today than at the coming of Europeans.

3. Various ancient peaks are indicated by the archeological record in different parts of the New World. The first high population level was reached in Central America and Mexico during the First Empire of the Mayas (with greatest density about 550 A. D.), and a second one of much greater extent obtained during the florescence of the Toltecs.

4. The chronological evidence indicates the greatest aboriginal population of America about 1200 A. D., this being a halcyon epoch of far-flung trade at the maximum expansion of wet-land cultures. The numbers of the red race may then have amounted to two or three times the present numbers, or say 50,000,000 to 75,000,000 souls.

5. Fluctuations have been much more evident in humid lands, tropical or temperate, than in arid lands.

6. The greatest factor in depopulation has been disease in epidemic form.

NOTE ON THE RAINFALL MAP

In compiling this map use has been made of official statistics where available (including the U. S. Weather Bureau's West Indian and Caribbean Service, Oliver L. Fassig in charge) and standard references such as Hann's "Handbuch der Klimatologie" and Supan's "Die Verteilung des Niederschlags," *Petermanns Mitt. Ergänzungsheft no. 124*, 1898. Also of the following:

Alfred Merz: Beiträge zur Klimatologie und Hydrographie Mittelamerikas, Leipzig, 1907.

M. W. Harrington: Central American Rainfall, *Bull. Philos. Soc. of Washington*, Vol. 13, 1895–1899, Washington, 1900, pp. 1–30.

W. W. Reed: Climatological Data for Central America, *Monthly Weather Rev.*, Vol. 51, 1923, pp. 133–141, Washington, D. C.

Paul Heidke: Regenmessungen aus Guatemala, *Deutsche Übersee. Meteorol. Beobachtungen*, No. 23, 1922, pp. A 26–30, Deutsche Seewarte, Hamburg.

Karl Sapper: Grundzüge der physikalischen Geographie von Guatemala, *Petermanns Mitt. Ergänzungsheft No. 113*, 1894.

Karl Sapper: Verteilungen des Regenfalls in nördlichen Mittelamerika (map). *Petermanns Mitt.*, Vol. 43, 1897, Pl. 10.

Karl Sapper: Die Alta Verapaz (Guatemala), *Mitt. Geogr. Gesell. in Hamburg*, Vol. 17, 1901, pp. 78–214.

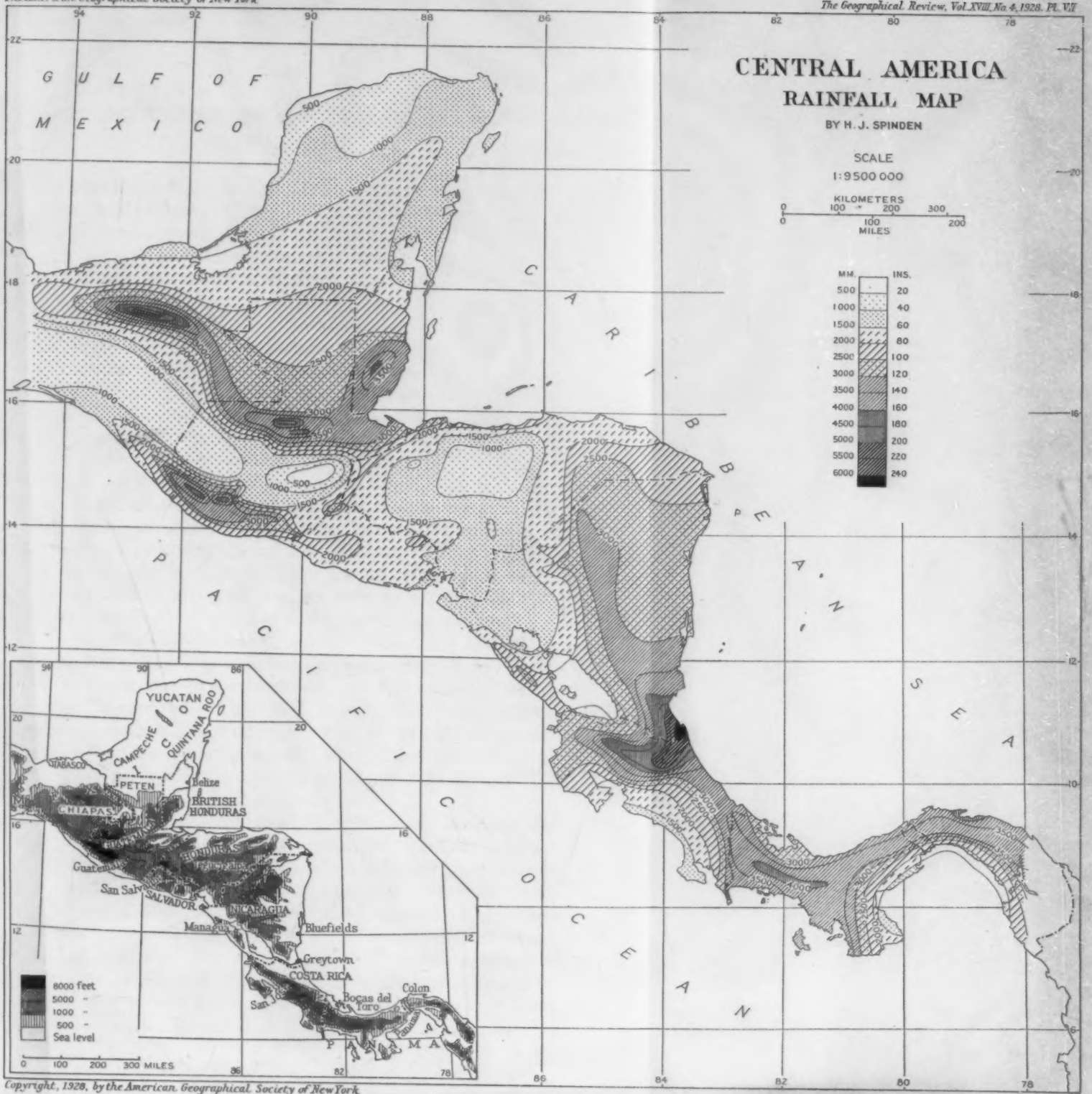
Eckhard Lottermoser: Die Ergebnisse der Temperatur-Beobachtungen in Salvador und Süd-Guatemala, *Mitt. Geogr. Gesell. in Hamburg*, Vol. 24, 1909, pp. 31–84.

Eckhard Lottermoser: Die Regenverhältnisse Mittelamerikas mit besonderer Berücksichtigung von Salvador und Süd-Guatemala, Inang. Diss., Tübingen, 1911.

A. P. Davis: Hydrography of Nicaragua. *Twentieth Ann. Rept. U. S. Geol. Survey*, 1898–99, Part IV, Hydrography, Washington, 1900, pp. 563–637.

Rainfall records kept by commercial corporations and private individuals, mostly unpublished, including: records from the United Fruit Co. (Tela Railroad, Truxillo Railroad, etc.) in Guatemala, Honduras, Costa Rica, and Panama; the Cuyamel Fruit Co. (Cortes Development Co., etc.) in Honduras and Nicaragua; Vaccaro Brothers (Suiza Planting Co., etc.) in Honduras; Schlubach, Sapper & Co., Guatemala; Spencer Richardson, Las Cañas, Matagalpa, Nicaragua; from stations on the Salvador Railway Co.; from mines of Charles Butters, Salvador, Honduras, Nicaragua; and Minor C. Keith, Guatemala and Costa Rica, etc.

The Geographical Review, Vol. XVIII, No. 4, 1928. Pl. VII



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UNIV. OF MICH.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS

A REPORT upon the twelfth International Geographical Congress, held at London (July 14–17) and Cambridge (July 18–25) under the authority of the International Geographical Union, properly begins with an acknowledgment of British hospitality. The delegates and members to the number of several hundred (over 500 registered) were received and entertained in a spirit which greatly promoted the friendly interchanges that are among the best features of international assemblies. In addition to delegates from the 19 countries that have adhered to the Union there were present representatives of at least 12 other countries. If the absence of German, Hungarian, and Austrian delegates was remarked it was always accompanied by expressions of good will, admirably set in relief toward the close, by the reference of Sir Austen Chamberlain to "the welcome that is waiting for them." It was because of similar assurances from French representatives in 1927, following direct overtures at Berlin, that local American opposition to or at least apathy toward the International Geographical Union disappeared. Official relations were established early in 1928, and eight accredited delegates for the United States (*Science*, No. 1746, Vol. 67, 1928, June 15, p. 604) were sent to the Congress. In addition there was formed in the United States by the National Research Council a National Committee representing the principal geographical organizations. It will be the duty of this Committee to coöperate with the Executive Committee of the Union in carrying out the work of the latter: promoting exchanges of information, assisting in the work of the various commissions engaged in the study of specific geographical problems, and planning American participation in the next International Geographical Congress to be held at Paris in 1931.

The British National Committee did not merely welcome and entertain. It arranged a series of excursions, carefully selected, timed, and carried through. And it made a permanent contribution of the first order in the shape of a regional geography entitled "Great Britain,"[1] a copy of which was presented to each member. The volume has the great advantage of presenting the many different styles, methods, and points of view of the twenty-six British geographers who contributed sections of the text. One is tempted to quote extensively from it, so excellent is some of the material found in every

[1] Great Britain: Essays in Regional Geography by Twenty-Six Authors with an Introduction by Sir E. J. Russell. Edited by Alan G. Ogilvie. Cambridge, The University Press, 1928.

paper. It is perhaps sufficient to say that it is now the standard reference on the subject and will attract the interest of every geographer not only for its material but for the methods of what may be called the British school. The effect upon the Congress of so serious a contribution should not be overlooked by those committees that have the responsibility of arranging future programs. Equally noteworthy in their effects were the printed reports of the various commissions recommended by the last Congress and advanced by the Union during the past three years. Included in the list of available publications was an excellent map (in three colors; 12 inches to 1 mile) of part of the town of Cambridge, specially prepared by H. M. Ordnance Survey.

Geographical Congresses: History and Purpose

An international congress seems to have three principal results: the bonds of friendship are strengthened amongst members of a profession, there is a volume of "proceedings," and provision is made for the continuation through "commissions" of research enterprises that require international coöperation.[2] It is doubtful if the International Millionth Map of the World (Carte du Monde au Millionième) would have been initiated, and it would most certainly not have fared so well, if it had not come repeatedly before geographical congresses since its first proposal by Professor Penck at the Congress of Berne in 1891. The commission form of organization for continuing work gives direction to research and thus provides for that concentration upon limited objectives which is generally lacking in the several section meetings. It would be contrary to the spirit of an international congress to exclude weak papers. Every one must be heard. The most diverse points of view are presented often with no real opportunity for discussion. Groups of quite disconnected papers may be given. The result would be confusing if it were not for the commissions which focus the work of groups with like interests and supply related papers in at least some of the sections. The growth of the work of the commissions seems likely to make the congresses of the future increasingly valuable.

The development of geographical congresses is summarized in a timely review by Sir Charles Close, published in pamphlet form for distribution at Cambridge.[3] Every geographer should obtain a copy of this interesting address delivered at the Anniversary General Meeting of the Royal Geographical Society in June, 1928. It contains an invaluable account of the history of international geographical

[2] Reference should here be made to the report by Professor Baulig of the International Geographical Congress held at Cairo in 1925 (*Geogr. Rev.*, Vol. 15, 1925, pp. 470–474).

[3] Colonel Sir Charles Close: International Geographical Congresses: A Brief Account of Their Origin, History, and Proceedings, Royal Geographical Society, London, 1928. It appears in the August number of the *Geographical Journal*.

congresses from the first one held at Antwerp in 1871 down to the one held at Cairo in 1925. Here will be found a summary of the most important resolutions passed, ideas presented, personalities engaged, and the character of the communications. The conclusion offers a point of view as to the content of geography.

Reports of Commissions

Because the programs of past geographical congresses have dealt predominantly with physical and mathematical geography it was gratifying to see a substantial monograph and sectional papers on an important phase of human geography—the rural habitat. Besides the scholarly and thought-provoking preface by Professor Fleure and the monographic treatment of all aspects of the question by Professor Demangeon in the longest chapter in the report (La géographie de l'habitat rural) there are intensive studies of specific regions: Rural Settlements in South-West Wales (Bowen), The Village Community of Alderney (Harris), and similar studies by Sayce, Leeds, King, and Grant. Clearly the European studies of rural groupings, with their necessary emphasis on the historical evolution of types of cultivation, are of a character quite different from those that have been pursued in the New World. The agricultural development of America has had definite stages and changes, but these reflect economic conditions rather than the broad social effects such as accompany political and racial revolutions. Mexico is perhaps the sole exception.[4]

Professor E. de Martonne, in Publication No. 3 of the International Geographical Union, "L'extension des regions privées d'écoulement vers l'océan" (collaboration of L. Aufrère) has brought to a conclusion a work upon which he has been engaged for some years. A first report at Cairo in 1925 was followed by a paper and map in the *Geographical Review* in 1927; and the map, subsequently republished in the *Annales de Géographie*, now reappears in the definitive report. A fully documented description is given of the method and its detailed application, region by region. Thus geography has contributed to geology, to plant and animal ecology, and to history as well, a critical statement as to interior-basin drainages and related climates over the world as a whole and from the best descriptions and cartographic sources.

Under the presidency of Sr. Hernández-Pacheco of Madrid there was brought out in preliminary form a "Report of the Commission on Miocene and Pleistocene Terraces" (International Geographical Union, Publication No. 2). It consists of nineteen papers dealing with coastal terraces and beaches, fluvial terraces in relation with the coast, changes of climate and in the level of the land. Most of the papers deal with Mediterranean shores and drainages; one group

[4] See G. M. McBride: Land Systems of Mexico, *Amer. Geogr. Soc. Research Ser. No. 12*, 1923.

with the British Isles, and a few Asian and more distant African examples. The report consists of related papers, but no general conclusions are drawn. Hernández-Pacheco and others summarize the river-terrace conditions of Spain, and Wright the raised beaches of the British Isles. But much further regional work is required before a larger synthesis can be attempted.

The Papers Read

It would require too much space to make suitable reference to each paper in the program. For the titles of papers, the organization of the Congress, the personnel of committees, the receptions, map exhibitions, special lectures, excursions, and abstracts of papers, reference should be made to the "Handbook for the International Geographical Congress" (with additions and corrections). The Congress was divided into six sections—Mathematical, Physical, Biological, Human, Historical, and Regional; and these met simultaneously between 10.00 and 12.30 a. m., the afternoon being given to excursions and general lectures. Without discriminating between a large number of interesting papers and excursions, special mention may be made of a few by way of illustrating the range and character of the program. The Dean of Norwich (Dr. Cranage) gave an extraordinarily interesting historical account of "Cambridge: The Town and University," especially valuable for those foreign members who were visiting for the first time an old English university town. The classic query—What is geography?—had a new and stimulating answer in "The Content of Philosophical Geography" by Sir Halford Mackinder. Professor Almagià presented his nearly complete "Monumenta cartographica Italiae," a collection of 65 reproductions of early maps and 55 pages of text. H. R. H. the Duke of Apulia gave an illustrated general lecture on his recent explorations in "The Tripolitanian Sahara." The brilliant archeological results obtained by aerial photography in southern England were presented by Mr. O. G. S. Crawford.[5] A group of distinguished papers on Egypt was an interesting feature of the program. Besides Hussein Sirry Bey's papers on the cartography of Egypt, and a physiographic paper by Dr. Hume, there were addresses by Desio (Giarabub Oasis), Awad (Evolution of the Nile), Hug and Lozach (The Rural Habitat), Selim (Trade in the Middle Ages), and Amer (strikingly rapid population growth as affected by the change from the basin system to the perennial system of irrigation). Dr. Uchida's analysis of cultivated land in Japan presents an analogous study of dense population: fifteen per cent of the land supports half the families, and rice culture

[5] See O. G. S. Crawford: Air Survey and Archaeology, *Ordnance Survey Professional Papers No. 7* (N. S.), Southampton, 1924.

(supporting the highest densities) compels the use of land of limited selection, while a paper on the population of Denmark, by Professor Vahl, explained how the densities vary in response to the contrasts in practices upon large estates and small holdings and forests and open country even where there are no differences in fertility. A notable series of papers (based largely upon the work of the corresponding commission) related to the rural habitat in Italy, Egypt, Yugoslavia, Czechoslovakia, France, and England. Special mention may be made of Mlle. Lefèvre's paper on a general classification of types of habitat.[6] Another group dealt with climatic variations (Gregory), the climate of prehistoric Greece (Myres), of England in the seventeenth century (Baker), of Poland from the fifteenth to the seventeenth century (Polacsch), and of southeastern France (Bénévent). Professor De Marchi proposed a commission on climatic variation.

Physiographic papers concerning such diverse themes as interior-basin drainage, coastal evolution, speleology, loess, and crustal dislocation were presented by Romer, Johnson, Calciati, Atwood, Barbour, Yamasaki, and Imamura. Professor Romer strongly challenged de Martonne's method of determining the units of interior-basin drainage and outlined new principles to guide further investigation. Dr. Barbour shed new light on the origin of loess in a period when man was driven out of western-central China by the severity of the climate, to return again by way of the broad valleys. A group of printed papers dealing with the scientific exploration of the Red Sea was presented by Captain Mancini, director of the Royal Italian Hydrographic Institute. Dr. Negri presented the studies of the Italian National Committee on the plant and animal life of high mountains. De Filippi described his Central Asian Expedition of 1913–1914; and Sir Francis Younghusband gave an account of the Shaksgam Valley. Papers by Deherain, Fordham, Stevenson, Castro, Myres, and Mackinder ably represented the field of historical geography and discussed the geography of Ptolemy, the history of exploration, the historical geography of England, and early Spanish mapping in the New World. Atlases, surveys, projections, geodesy, and cartography were the subject of papers by Sir Charles Close and Hussein Sirry Bey (New Atlas of Egypt), Hinks, Romer, Werenskiold, de Lavalette, Reeves, Jones, and Bognetti (International Atlas of the Italian Touring Club with sources and text in Italian, French, German, Spanish, and English). Equally valuable were the many other papers in other fields of geographical research such as economic geography including transportation, educational geography, aerial photography, and city geography.

[6] See also Marguerite Lefèvre's "L'habitat rural en Belgique: Étude de géographie humaine," Bibliothèque du Séminaire de Géographie de l'Université de Louvain, H. Vaillant-Carmanne, Liége, 1926.

Excursions and Social Events

Among the several excursions to near-by localities special mention may be made of one only: Wicken Fen. An excellent paper on the Fenlands by Professor Frank Debenham, of the Department of Geography at Cambridge, is published as one of the regional studies in "Great Britain," the volume noted above. There was also made available an interesting pamphlet by Professor G. Stanley Gardiner published on behalf of the Local Committee of the "National Trust for Places of Historic Interest or of Natural Beauty." With these documents and under the leadership of Professor Gardiner a party was able most profitably to visit and understand the evolution of the fen country. Ely Cathedral, whose history is closely connected with that of the original waterways and marshes of the neighborhood was visited en route. Of the post-Congress excursions mention may be made of a tour to Wales under the direction of Professor Fleure to study "The physical features of Wales, the Snowdon Range and its dissection, the great estuaries,—the coal valleys, the Wye Valley and its incised meanders—[and] the natural regions of Wales from the human point of view."

The President and Council of the Royal Geographical Society of London received the members of the Congress on July 14. The Science Museum at South Kensington invited members to inspect its geographical, meteorological, geodetic, and astronomical collections. The Lord Mayor of London and the Corporation of the City of London arranged a Reception and Conversazione at the Guildhall which was honored by the presence of H. R. H. the Prince of Wales. Addresses by the Vice-Chancellor of the University of Cambridge and by General Vacchelli, President of the Union and the Congress, opened the program at Cambridge. At a later session the Vice-Chancellor conferred honorary degrees upon General Vacchelli, Colonel Sir Charles Close, and Professor de Martonne in the presence of a distinguished gathering in the historic Senate House. The climax of the social chapter of the Congress was the complimentary dinner to the delegates by H. M. Government in Trinity College where Sir Austen Chamberlain, Secretary of State for Foreign Affairs, presided, afterwards receiving the guests in St. John's College. Special mention should be made of the hospitality of the Masters of colleges who arranged receptions or entertained guests: the Masters of Pembroke, Gonville and Caius, Emmanuel, Jesus, St. John's, Trinity, Sidney Sussex, Christ's, St. Catherine's, and Magdalene. The Principal of Newnham and the Mistress of Girton invited members to tea, and Dr. Alan Gray of Trinity College Chapel gave an organ recital.

The Captain Scott Polar Research Institute received a limited number of members of the Congress; and, on behalf of the Managing

Committee, Dr. Hugh Robert Mill described the objects of the Institute, its collections, its future possibilities.

The International Map of the World

There remains to mention the work of the Commission on the Millionth Map of the World. The meeting, held at the house of the Royal Geographical Society, was attended by official representatives of about twenty nations. Agreement was quickly reached upon a number of additions and changes in the conventional sign sheet. A less cumbersome group of symbols for international boundaries was adopted, and likewise new signs for wireless telegraph stations, oil wells, tunnels, railway stations, aerodromes with hangars, landing grounds for airplanes, airship stations. The relative reliability diagram, a feature of the sheets of Hispanic America published by the American Geographical Society, is now made a requirement for standard sheets. It is proposed hereafter to publish two key maps for sheets issued: one for standard sheets from whatever source derived, whether official or unofficial, and a second for sheets that do not conform to the standard requirements. It may be noted here that the International Geographical Union approved Mr. Crawford's proposal to publish in a special edition those sheets of the Millionth Map that included the territory of the Roman Empire at its greatest extent, with a special symbolism for features of historical, archeological, and geographical interest.

At the final plenary session of the Congress General R. Bourgeois was elected President of the Union, General Vacchelli First Vice-President, and Dr. Filippo De Filippi Secretary-General. An Executive Committee of eight, including the above, acts during the ensuing three years as a continuing body charged with the organization of the next congress at Paris in 1931.

THE CENTENNIAL CELEBRATION OF THE GESELLSCHAFT FÜR ERDKUNDE ZU BERLIN

The following report on the centennial celebration of the Gesellschaft für Erdkunde zu Berlin is made by Mr. J. A. Morrison, of the University of Chicago, acting as representative of the American Geographical Society.

Towards the end of May the world's second oldest geographical society and the oldest geographical society in Germany celebrated its 100th anniversary. The occasion was signalized by inviting the various German and foreign sister societies to send delegates to take part in the commemorative exercises and to attend the Oceanographic Conference held in conjunction.

The Gesellschaft für Erdkunde hospitably welcomed the many delegates with a luncheon given in its rooms at 23 Wilhelmstrasse. After the luncheon Sir Douglas Mawson, of the University of Adelaide, South Australia, gave an extremely interesting and strikingly illustrated lecture on the Australian Antarctic Expedition, of which he was the leader.

The formal opening of the centennial celebrations was signalized by a Festsitzung held in the Plenarsitzungsaal of the Reichstag on Thursday evening, May 24, when every seat in that historic chamber was occupied. The President of the Gesellschaft für Erdkunde, Dr. Albrecht Penck, opened the session with an address and speech of welcome to the visiting delegates. In his address, Dr. Penck traced the historical development of the Gesellschaft from the time when it was only a small group of congenial students of natural science under the inspiration of Alexander von Humboldt and Karl Ritter through the von Richthofen period, when its connection with exploration was made famous by the work of German explorers in Africa and China, down to the present time. In closing, Dr. Penck urged that, the outlines of the earth now being known, the task before geographers the world over is to bring their training and knowledge to bear on the problems of population. The international note thus struck continued throughout the entire proceedings.

After the reading of greetings from the President and Chancellor of the German Republic, the representative of the world's oldest geographical society, Charles de La Roncière, vice-president of the Société Géographique de Paris, read an address in French, in which he extolled the work of German geographers and explorers. After conveying the formal greetings of his society, he presented its medal to the Gesellschaft für Erdkunde. Following him came Sir Maurice de Bunsen, representing the third oldest geographical society in the world, the Royal Geographical Society of London. Then Professor Maull spoke for the second oldest geographical society in Germany, the Verein für Geographie und Statistik of Frankfurt am Main. He was followed by Commander Luymes of the Hydrographic Bureau of the Royal Dutch Navy, who especially commended the work of German hydrographers, Professor Otto Pettersson of the Swedish Hydrographic-Biological Commission, who spoke for the several Scandinavian societies and institutes represented, Professor Everardo Backheuser for the Instituto Historico e Geographico Brasileiro and the Academia Brasileira de Sciencias, Rio de Janeiro, Professor Dr. Pompeckij of the University of Berlin for the Berlin Hochschulen and Academy of Science, Minister of State von Sydow for the German and Austrian Alpine Clubs, Minister of State Dr. F. Schmidt-Ott for the Notgemeinschaft der deutschen Wissenschaft, Minister of State Dominik for the Deutsche Seewarte, and Professor Defant of the University of Berlin for the Institut für Meereskunde.

The remainder of the evening was devoted to the presentation of medals and honorary and corresponding memberships in the Gesellschaft für Erdkunde by Dr. Penck. The Karl Ritter Gold Medal was awarded to Alfred Merz in memoriam for his untiring efforts in organizing the German Atlantic Expedition. The Karl Ritter Gold Medal was also presented to Professor Alfred Hettner for his great service to the methodical development of geography. Nachtigall Gold Medals were bestowed on Professor Karl Sapper of Würzberg for his researches in Central America and on Sir Douglas Mawson for his contribution to our knowledge of Antarctica. Nachtigall Silver Medals were presented to Captain F. Spiess and Dr. Georg Wüst for the thorough manner in which they carried out Merz's great plans for oceanographic research with the *Meteor*, to Lauge Koch (Copenhagen) for his exploration in Greenland, to Captain George Wilkins for his flight over the North Pole (presented to Captain Wilkins in person upon his arrival in Berlin), to the oceanographer Dr. Harald U. Sverdrup (Bergen) for research in the Arctic, to Dr. Björn Helland-Hansen, Director of the Geofysiske Institut, Bergen, for his oceanographic research in the northern Atlantic and the European sector of the Arctic, to Dr. Ernst Nowack (Vienna) for his work on the geology of Albania, to Dr. Anatole von Reinhardt (Leningrad) for glacial research in the Caucasus, and to Hermann Lautenbach for his service in raising the quality of geographic instruction in Germany. Several honorary and corresponding memberships in the Gesellschaft für Erdkunde were also awarded.

The Oceanographic Conference was opened by its chairman, Minister of State Dr. Schmidt-Ott, on Friday morning, May 25, in the main auditorium of the Langenbeck-Virchow Haus. Dr. Schmidt-Ott paid tribute to the work of earlier oceanographic expeditions, especially that of the *Challenger*, and eulogized the splendid results of the *Meteor* expedition.

Professor A. Defant, of Berlin University, read the first paper, "The Systematic Exploration of the Oceans." The international spirit of the conference was emphasized in his plea for international coöperation in solving the remaining problems of oceanography. The distinguished chemist, Professor Dr. Fritz Haber, in a paper on "Gold in the Sea," then proceeded in a semi-humorous vein to put a quietus on the recurrent belief that the water of the oceans contains untold amounts of gold in solution. The last paper of the morning session, "Marine Exploration with Small Vessels," was by Professor Björn Helland-Hansen. He demonstrated the value of the small ship with a limited radius of action for oceanographic exploration in the narrow seas and in the coastal waters of the oceans. As a demonstration of the interest of the German Government in the centennial celebration and the Oceanographic Conference, a luncheon was tendered the foreign delegates by the Ministry for Foreign Affairs at 8 Wilhelmplatz.

At the afternoon session of the Oceanographic Conference two papers carried over from the general session were read: the first by Dr. Johan Hjort of the Norske Geografiske Selskab, Oslo, on "The Program of International Marine Exploration," the second on "The Proposed Netherlands Expedition" to the waters of Insulinde by the Director of the Koninklijk Nederlandsch Meteorologisch Institut, P. M. van Riel.

Then followed the first of a series of papers dealing with the work and results of the *Meteor* expedition, "The Oceanographic Work of the German Atlantic Expedition," by Dr. Georg Wüst, General Secretary of the Gesellschaft für Erdkunde and one of the prime movers of the expedition. "The Biological Work of the German Atlantic Expedition" was discussed by Professor Dr. E. Hentschel of Hamburg, "The Chemical Work of the German Atlantic Expedition" by Dr. H. Wattenberg of Munich.

The centennial banquet of the Gesellschaft für Erdkunde took place Friday evening, May 25, in the ball room of the new Restaurant Kroll on the Platz der Re-

publik, with Dr. Penck presiding. Almost five hundred guests were present. The first toast was proposed by Dr. Penck to President von Hindenburg and was followed by the singing of the national anthem. The continued success and well-being of the Gesellschaft für Erdkunde during its second century and the health of its distinguished Director were proposed by Professor Dr. Eugen Oberhummer, the president of the Geographische Gesellschaft of Vienna, in the name of all the foreign delegates. After the reading of congratulatory telegrams from all parts of the world, Director Penck announced the arrival of the *Italia* at the North Pole. His proposal that a congratulatory radio message be sent to her commander was accepted with acclaim.

The third and final session of the Oceanographic Conference took place on the following morning. Continuing the series of papers dealing with the *Meteor* expedition, Professor C. W. Correns of Rostock discussed "The Mineralogical-Geological Work of the German Atlantic Expedition," and Dr. H. Maurer of Berlin "The Echo-soundings of the German Atlantic Expedition." The final paper was read by Captain Spiess, commander of the *Meteor*, on "The Expedition Ship *Meteor* and Its Tasks." In closing the Conference, Dr. Schmidt-Ott thanked the speakers for their interesting and illuminating contributions and expressed the hope that the intensive exploration of the sea carried out by the *Meteor* expedition would be continued by other nations working under a common plan.

As a happy conclusion to the combined centennial of the Gesellschaft für Erdkunde and the Oceanographic Conference, an excursion to Potsdam was generously provided on Saturday afternoon by the city of Berlin for the Gesellschaft für Erdkunde and its guests. The excursion offered a pleasant opportunity for the renewing of old acquaintances and the forming of new ones. Several of the geographers who took part in the Transcontinental Excursion held in connection with the 60th anniversary of the American Geographical Society were present and recalled with pleasure that memorable event and the contacts made at that time with American geographers.

The commemorative "Sonderband," edited by Dr. Albrecht Haushofer and with a foreword by Professor Penck, is an attractive volume of 551 pages. Gustav Hellmann narrates the history of the Society in the latter half of its existence; the history of the previous half century is told in a heretofore unpublished address by Richthofen, given on the occasion of the fiftieth anniversary in 1878. The remaining contents are well chosen to represent the broad scope of the work now being done by German geographers. Thus, without attempting to list all the papers, we may instance Penck's "Neuere Geographie"; Sapper's "Ein Beitrag zur Paläogeographie Mittelamerikas"; Troll's "Die zentralen Anden," with a diagrammatic physiographic map in color; Franz Kühn's beautifully illustrated "Typen der andinen Landschaft zwischen 35° und 36° südl. Breite"; Jäger's "Die Gewässer Afrikas," with a colored hydrographic map novel in conception; Lautensach's "Morphologische Skizze der Küsten Portugals," with colored geological map; Friederichsen's "Ostpreussen," with Sheet N. N.–34 of the International Millionth Map of the World, finely executed; Louis's "Die neue Karte von Albanien," the map another admirable piece of cartography, in color, two sheets, on the scale 1:200,000; Finsterwalder's "Neue Aufgaben der Kartographie"; Defant's "Die systematische Erforschung des Weltmeeres"; and Wüst's "Der Ursprung der atlantischen Tiefenwässer."

The collected papers of the German Atlantic Expedition, "Berichte der Deutschen Atlantischen Expedition auf *Meteor* 1925–1927," have also been issued in similar form.

GEOGRAPHICAL RECORD

NORTH AMERICA

Wheat and the Canadian Prairie Provinces. "Canada has begun to harvest a wheat crop which will be, according to the experts, the greatest in her history, and the Prairie Provinces in particular are jubilant over the outlook" . . . "to assist in taking off the phenomenal crop 10,000 men are being brought to Canada from Britain" (press report in the *New York Times* from Ottawa, August 15). The

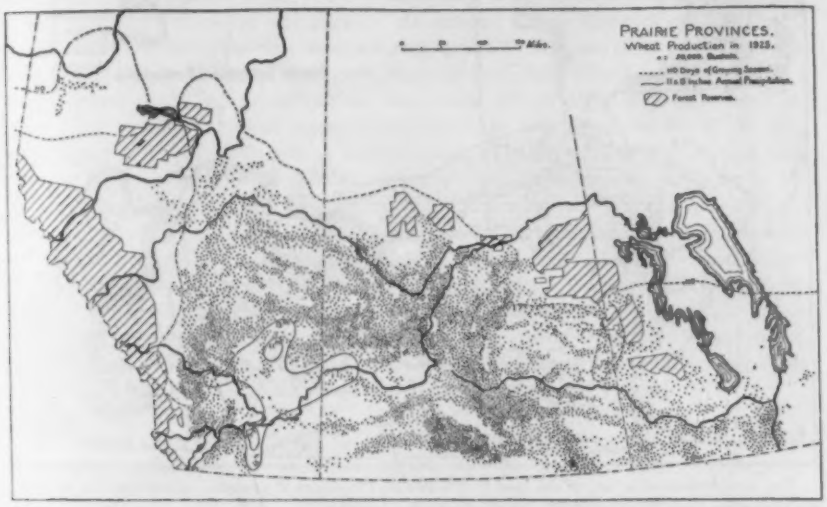

FIG. 1—Wheat production of the Prairie Provinces of Canada, reproduced on a reduced scale from Figure 5 of Dr. Jones's paper in *Geography* (the magazine of the (British) Geographical Association). Note the minimum rainfall area of southern Alberta.

Prairie Provinces have vast deposits of coal, great stores of pulp wood and potential water power, metallic ores "not popularly associated with them," and other agricultural resources; but wheat still remains the basis of prosperity. The accompanying maps of wheat production and of land utilization, reproduced from an excellent paper by Ll. Rodwell Jones, "Some Physical Controls in the Economic Development of the Prairie Provinces" (*Geography*, Vol. 14, 1928, pp. 284–302), tell a good deal of the story into which historical and economic factors enter as well as the geographical setting.

The area shown on the land utilization map as devoted to wheat is essentially coincident with the belt of natural prairie, passing on the northeastern border into the transition belt of grove land that lies between the prairie proper and the forest. The ranching area of the south is coincident with higher, drier, rougher land—the Wood, Cypress, and Milk River plateaus. Here is much abandoned farm land that should revert to ranching with supplementary winter fodder crops grown by irrigation. The belt of mixed farming bordering the wheat area is largely on grove land, or park land, as it is usually termed by the botanists (see the description of the Alberta park land in "The Vegetation of Alberta: II. The Swamp, Moor and Bog Forest Vegetation of Central Alberta," by F. J. Lewis, E. S. Dowding, and E. H. Moss,

Journ. of Ecol., Vol. 16, 1928, pp. 19–70), which has a slightly lower temperature and shorter growing season and greater effective precipitation. About Winnipeg longer settlement, a large urban population, and more moisture have encouraged the tendency toward mixed farming and dairying. The growth of irrigation in the southwest will also call for a greater range of rotation crops for the best use of the land.

If natural conditions have favored the growth of wheat, the demand of the European market has made its exploitation possible, and this has required efficient

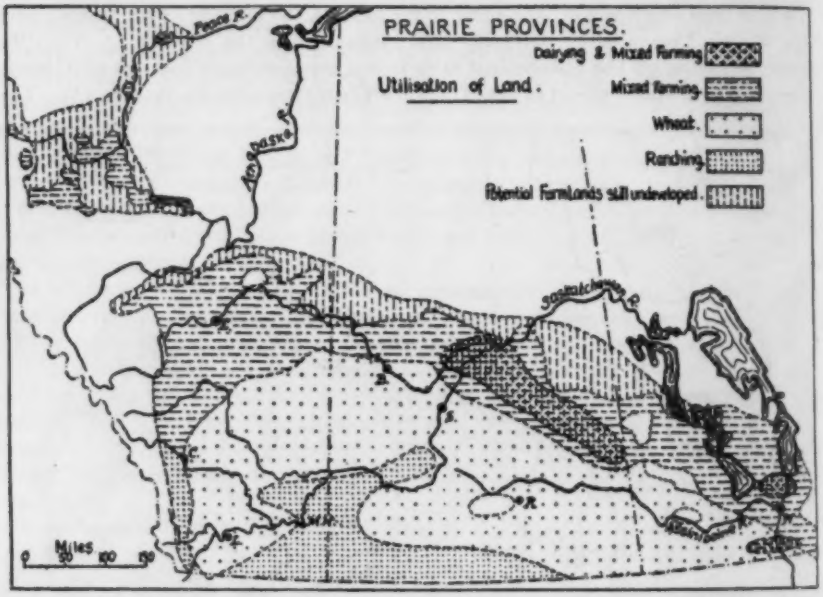

FIG. 2—Map showing use of the land in the Prairie Provinces of Canada, reproduced on a slightly reduced scale from Figure 6 of Dr. Jones's paper in *Geography*.

transportation. On the prairies railways have notably preceded settlement. Today "at least three-fourths of the true prairie territory is within 20 miles of the railway." The map of settlement now begins to show certain areas of lesser natural productivity; some so obvious that they have been avoided by the railway, some within rail reach but relatively thinly occupied. The irregularities of distribution may be studied with profit, and Dr. Jones lays a good deal of stress on the variation due to topographic irregularities. Transport remains an important question in the Prairie Provinces. Though there has been a large expansion of market westward and Vancouver is now the third wheat port of the North American continent, the Provinces are bent on the improvement of eastward facilities. Work on the Hudson Bay railway has been resumed—to a new terminal, Fort Churchill, instead of Port Nelson.

On the Peace River Country, not discussed by Dr. Jones, reference may be made to a recent pamphlet by F. H. Kitto published by the Department of the Interior, Canada (Ottawa, 1927). The agricultural country of the Peace River district is said to occupy an area of 73,500 square miles, considerably larger than the New England states. It has a favorable climate and fertile soil and, since the arrival of the railway from Edmonton in 1916, is rapidly growing in population. Three types of agriculture are now engaged in—straight grain growing, mainly spring wheat, mixed farming, and ranching. The "average prospective settler" is advised to turn to mixed farming, with the safety factor that it implies.

Natural Resources of the Cincinnati Region. The distribution of the mineral industries of Ohio as based on materials native to the state is depicted on a map accompanying the publication "Mineral Industries of Ohio" by J. A. Bownocker and W. Stout (*Geol. Survey of Ohio Bull. 33, 4th Ser.*, 1928). Since these industries are largely connected with oil, gas, and coal resources, a marked concentration of them occurs in the eastern and northern parts of the state. With the exception of ceramic plants and sand and gravel pits, the map shows the Cincinnati sector as notably deficient in mineral industries.

Cincinnati, on the main line of travel west from the Alleghenies, was originally a product of the Ohio River and the surrounding country, field and forest. It became a city whose activities were largely meat packing, distilling, buggy-making, and river trading. Since that time, changing conditions have largely destroyed the significance of its Ohio River location; and its new industries are not related in so simple a manner to the natural resources of the region. At present the localization of industry is many-sided—certain types of manufacturing locate at the source of raw materials, other kinds as near the market as possible or at centers of transportation or near a favorable labor supply, and still others because of some relationship to another industry. In seeking the most favorable adjustments of the activities of the city to its region and determining what kind of industrial expansion would be most suitable, the Commercial Club of Cincinnati in 1924 sponsored a resource survey by the Department of Geology and Geography of the University of Cincinnati. Most of this work consisted of selecting, organizing, and supplementing material from state and federal surveys. The result is a series of reports on the various resources and industries of the area by members of the Department of Geology and Geography, graduate students of the department, and other members of the faculty. These detailed reports have not been published, but they can be consulted in the offices of the Resource Survey. Nevin M. Fenneman has abstracted them in the *Univ. of Cincinnati, Inst. of Sci. Research* [*Publs.*], *Ser. 2, No. 1*, June, 1927.

Landslide Lakes in the Great Basin. One of the largest and most remarkable of seven landslide lakes in the northwestern part of the Great Basin, recently described by H. J. Russell, is now extinct ("Landslide Lakes of the Northwestern Great Basin, "*Univ. of California Publs. in Geogr.*, Vol. 2, 1927, pp. 231–254). It occupied a 5-by-2-mile down-faulted basin in northwestern Nevada, known as High Rock Valley, which is enclosed on the east by the bold scarp of an unnamed, upfaulted, basalt-capped lava block that slants eastward under Black Rock desert; and on the west by the step-faulted slope of a slanting lava plateau, which rises for over 30 miles westward to the fault crest of the Hays Canyon Range, that overlooks the 50-mile down-faulted and aggraded trough of Surprise Valley in northeastern California, of the floor of which the same author has given a detailed description ("The Land Forms of Surprise Valley, Northwestern Great Basin," *Univ. of Calif. Publs. in Geogr.*, Vol. 2, 1927, pp. 323–358). The slanting lava plateau is deeply trenched, especially by two profound canyons which drain westward into High Rock Valley; and the western unnamed fault block (illustrated by a good photograph) is cut through near its highest part by another canyon, which is taken to be the work of a stream that continued from the canyons of the slanting plateau and, under a moister climate than that of today, maintained its eastward flow, antecedent fashion, by aggrading the floor of the down-faulted basin and trenching a canyon through the upfaulted block. This canyon later became obstructed by a heavy landslide to a height of 600 feet; whereupon a lake, still recorded by high-level deltas and shore lines, rose 400 or 500 feet in the basin until it overflowed, not down the canyon obstructed by the landslide but at a sag in the fault-block crest three miles north of the obstructed canyon, and there cut down a second canyon to within 50 feet of the present basin floor. Overflow then failed, as if because of increasing aridity. The basin today, although

receiving the drainage of 500 or 600 square miles, has no outlet; a wet-weather lake which sometimes overspreads its playa floor is seldom more than two or three feet deep.

A closely similar and perhaps larger landslide lake was formed near the western base of the great Warner Range fault block, at the east base of which lies the above-named Surprise Valley.

W. M. Davis

SOUTH AMERICA

The Historical Geography of Northwestern Argentina. A succinct account of "The Historic Geography of Tucumán" (*Univ. of California Publs. in Geography*, Vol. 2, 1928, pp. 359–386) is a recent addition by Oscar Schmieder to his several South American studies. The area dealt with, the old colonial government of Tucumán, is one of particular interest lying as it does between Andean highland and Pampean plain and influenced by both in varying degree and at various times. The south-trending structural valleys make for easy transition between mountain and plain, and here the dryness of the climate has been a most important factor. (Parenthetically it may be remarked that the use by the author of Köppen's climatic symbols without characterization is a drawback to the general reader). Agriculture, except on the eastern margins adjoining the land of the nomadic Indians, is possible only by irrigation. The area, which was strongly influenced by Peruvian culture in pre-Columbian times, seems, however, to have supported a numerous population. Archeological remains—terraced fields, dams, ditches, walls—are very numerous. Apparently its apogee had been attained before the arrival of the Spaniards (compare H. J. Spinden's paper, elsewhere in this *Review*). Some few allusions in the historical sources—and the general silence of the early writers is eloquent—also point this way. Dr. Schmieder hints at drought as a possible explanation. Commenting on Lozano's statement (Historia de la conquista del Paraguay, Rio de la Plata y Tucumán, 1745) that "a great emigration of the people of Tucumán took place into the Gran Chaco shortly before the Spaniards entered the area, a great drought with consequent famine being its cause," he says "one or several years of abnormally low rainfall, such as occur in arid regions, might easily have produced scarcity of crops, famine, and even a cultural crisis, since the warlike Indians of the plains could take advantage of the situation and invade the country."

Spanish colonization of Tucumán took place from the highlands, and the early settlements were extremely isolated. They prospered with the improvement of communications with Peru and the development of the cattle and mule trade. Not until the later nineteenth century was there any fundamental change in the character of the settlement. Then development of the Pampa as an agricultural region commenced (see Mark Jefferson: Peopling the Argentine Pampa, *Amer. Geogr. Soc. Research Ser. No. 16*, 1926. On earlier conditions see Oscar Schmieder: Alteration of the Argentine Pampa in the Colonial Period, *Univ. of Calif. Publs. in Geography*, Vol. 2, 1927, pp. 303–321; and *idem:* Die Entwicklung der Pampa als Kulturlandschaft, *Verhandl. und Wissenschaftliche Abhandl. des 22 Deutschen Geographentages zu Karlsruhe, June, 1927* (Breslau, 1928), pp. 76–86). Northwestern Argentina was drawn into its sphere of influence and turned away from the highlands. The recent completion of rail connection between Argentina and Bolivia should in some measure revive the old relation with the *altiplano*. The northwestern region retains a conscious unity. It is reflected in such a sectional development as the creation of a "Conferencia de Gobernadores" of Salta, Jujuy, Santiago del Estero, Tucumán, Catamarca, and La Rioja; the first held in 1926, a second in 1927 (see contemporary numbers of *Revista de Economía Argentina*), at which among other reforms improvement of rail communications in the northwest is strongly urged.

EUROPE

The Vegetation of European Russia. Readers unacquainted with the Russian language will be grateful to Professor Boris A. Keller of the Agricultural College, Vorónezh, for his account of the "Distribution of Vegetation on the Plains of European Russia" (*Journ. of Ecology*, Vol. 15, 1927, pp. 189–233), based on the great volume of data acquired by Russian plant geographers, soil scientists, and foresters. He describes and gives some explanation of the well marked climatic zonal distribution of the vegetation, and a series of maps show the zones and the limits of distribution of important tree species and the chief elements governing distribution—January and July isotherms, mean annual precipitation, soils, glacial geology. Special reference may be made to the last-named. "The most important historico-geological factors are first the great glaciers which formerly covered most of the plains to be described, and secondly the waters of the Caspian Basin which at one time spread over much of the southeast." The revegetating of these areas on the retreat of ice and water may still be traced through certain elements of the vegetation. The most important are the tundra vegetation, which supposedly first occupied the ground as the ice retreated; the coniferous forest, whose development was determined by the advance of the two leading coniferous species, the Norway spruce and Scotch pine; the mid-European broad-leaved deciduous forest, which dies out from west to east and does not extend beyond the Urals; the herb and grass vegetation of the steppes, which on the contrary represents migration from east to west; the semidesert and desert flora, which has its origin in the "great mountain and desert species-forming laboratory of Turkestan."

The relations of grassland and forest are everywhere of interest. Professor Keller discusses factors hindering the spread of the Russian forest southeastward—lack of moisture in conjunction with the fine-grained steppe soil, strong steppe winds, presence of harmful salts, competition with steppe grasses, fire. "We cannot however regard the problem of the causes . . . as definitely solved," he concludes, referring to the like case of the American prairies.

Variations of the Glaciers in Western Norway. From somewhat before the year 1700 till about 1750 the glaciers in western Norway, according to old records, underwent a remarkable expansion partly or completely overriding and destroying many farms (John Rekstad: Om varias joner av isbreene på Vestlandet, *Naturen*, Vol. 52, 1928, pp. 25–31). Ice tongues extending from the large Jostedalsbreen (7° E., 61° 30′ to 61° 40′ N.) formed during their maximum stand about the year 1750 moraines that lay 1100 to 2100 meters (3600 to 6900 feet) beyond the glacier ends in 1900. The records also tell of cold and rainy summers during which the crops did not ripen and the farmers suffered famine. Such years were 1685–1687, 1695–1697, 1705–1707, 1717, 1719, and 1740–1742.

Since 1750 the glaciers have been retreating. The rate was particularly great during the latter half of the last century. The recession has not been even but was interrupted by halts and advances, known fairly well since 1850 and more accurately since 1900, when annual measurements were begun on several glaciers under the auspices of the Bergen Museum. According to measurements on 15 glaciers the average length of the cycle of oscillation is 18 years, of which 7 years are occupied by advance and 11 years by retreat. The cycle is thus one-half as long as Brückner's cycle, which averages 35 years. The glaciers began to advance in 1921 and 1922.

ERNST ANTEVS

Wind Deserts in Iceland. Wind erosion is by far the most important form of erosion in Iceland; and the vegetation-free areas here are not cold deserts but wind deserts, as pointed out by Carl Samuelsson (Några studier över erosions-företeel-

serna på Island, *Ymer*, Vol. 45, 1925, pp. 339–355) and by Niels Nielsen (Landskabet Syd-Ost for Hofsjökull i det indre Island, *Geogr. Tidsskrift*, Vol. 31, 1928, pp. 23–44). A particularly instructive case is given by Nielsen. In front of the Hofsjökull, in the heart of the island, the recent moraines carry a continuous cover of vegetation, while the older moraines farther away from the glacier practically lack vegetation and undergo wind erosion. The moisture of the ground is very great near the glacier but decreases with distance; and it is evidently the strength of the wind and the cohesion of the soil, not the temperature, that determine whether vegetation can get a foothold or not.

With decreasing moisture wind erosion reaches its greatest intensity on the plateaus of the interior, and here the most extensive deserts are to be found. Strong cold winds sweep down from the glaciers, carrying away the silt and sand and exposing and polishing cobbles, boulders, and bed rock. The material is frequently carried down to the low and narrow coast land, where it forms a loess-like deposit. Here too, where deposition is chiefly taking place, the wind may quickly carry away the precious soil and destroy farm after farm, if the turf cover gets broken.

ERNST ANTEVS

Fractures and Fiords in the Faeroes. The Faeroes, beautifully mapped by Danish topographers, include more than twenty islands which spread 65 miles east-west in the north and trail 110 miles to the south. They result from the dissection of an upstanding part of the vast Thulean basalt field of the northeastern Atlantic. As described by James Geikie ("On the Geology of the Faeroe Islands," *Trans. Royal Soc. of Edinburgh*, Vol. 30, 1883, pp. 217–269), who first showed that the islands had been occupied by a local system of Pleistocene glaciers, the smooth-walled and trough-like valleys and fiords, trending northwest-southeast, by which the islands are divided, as well as the hanging cirques which sometimes open in the trough walls 1000 feet or more above the fiord level, and the rock-basin lakes which frequently occupy the trough floors, "all testify to powerful glacial erosion." Grossman and Lomas ("On the Glaciation of the Faeroe Islands," *Glacialist's Mag.*, Vol. 3, 1895, pp. 1–15) emphasized the abundance of cirques in 1895 but added "we do not believe the fiords and cirques were scooped out by the ice." The archipelago has lately been visited by M. A. Peacock (Recent Lines of Fracture in the Faeroes in Relation to the Theories of Fiord Formation in Northern Basaltic Plateaux, *Trans. Geol. Soc. of Glasgow*, Vol. 18, 1926–27, pp. 1–26), who studied the relation of the fracture system, on which many deep and narrow clefts have been eroded, to the theories of fiord formation, with the result that he, like Grossman and Lomas, minimizes glacial erosion and ascribed the fiords chiefly to an advanced stage of normal erosion on an assumed system of earlier formed, northwest-southeast fractures while the region stood higher than now.

The massive form of the islands, little dissected by side valleys although steep-falling side streams abound on the fiord-trough walls, testifies strongly against this conclusion; for the normal dissection of a basalt plateau would produce islands of ragged outline, like the Pescadores, an elaborately dissected lava plateau in the China Sea next southwest of Formosa (Bundjirô Kotô: Notes on the Geology of the Dependent Isles of Taiwan, *Journ. College of Sci., Tokyo Imp. Univ.*, Vol. 13, 1900–01, pp. 1–56). The intricate embayments of the fine-textured and multibranching Pescadores valleys must of course be ascribed to submergence after advanced dissection; but the simply outlined fiords of the coarse-textured Faeroe troughs do not demand submergence; they may and probably do result simply from the invasion of the troughs by the sea as the glaciers which excavated them melted away, for heavy glaciers can erode their troughs well below sea level.

W. M. DAVIS

AFRICA

The Forest Vegetation of Southern Nigeria and the Gold Coast. Two excellent studies of forest vegetation in British West Africa have recently appeared as *Oxford Forestry Memoirs*, "The Physiography of Southern Nigeria and Its Effect on the Forest Flora of the Country," by J. R. Ainslie (No. 5, 1926) and "The Gold Coast Forest: A Study in Synecology," by T. F. Chipp (No. 7, 1927).

Mr. Ainslie points out that though the relief of the southern provinces of Nigeria is comparatively insignificant, it has a marked influence on the vegetation, mainly

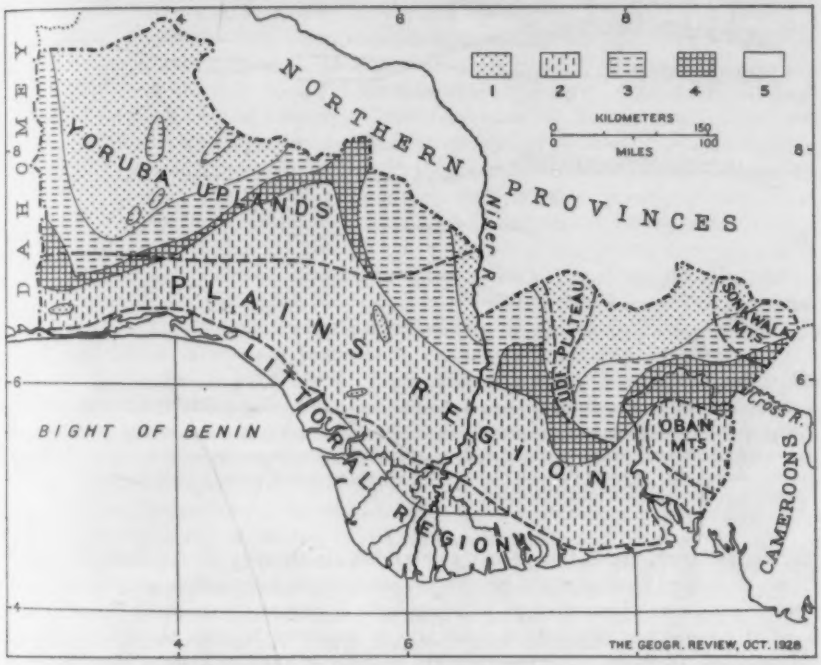

FIG. 1—Map showing the forest formations and physiographic regions of southern Nigeria, redrawn from Figures 4 and 7 of Mr. Ainslie's memoir. The numbers have reference: 1, savana; 2, tropical rain forest; 3, fringing and deciduous forest; 4, transition forest; 5, littoral forest. Scale approximately 1:7,000,000.

through the effect on water supply. The Niger delta directly exposed to the southwest monsoon wind of summer has as much as 126 inches annual rainfall. Inland the general rise in elevation is very gradual and rainfall steadily diminishes to 50 inches and less. Locally the influence of the northern belt of uplands, rising to 2000 feet in the highest hills, makes itself felt. In the southeast the Oban Mountains (1000 to 4000 feet) have a rainfall of over 150 inches: geographically and botanically they pertain rather to the Cameroons than Nigeria. Furthermore, they cut off the maximum rainfall effect from the Sonkwala Hills (6000 feet) to the north.

The littoral is characterized by mangrove forests where soil moisture is excessive and a low inferior type of evergreen forest on the sand banks. Inland lies the great belt of evergreen forest, rain forest, and, as an edaphic formation, fresh-water swamp forest. Much clearing for agriculture has taken place and as cultivation is mostly shifting large areas are covered with secondary growth, inferior and of a distinctly drier type. Such re-growth, says Mr. Ainslie, "is probably more marked in Nigeria than generally elsewhere in the tropics, partly because of the large areas involved

in this forest destruction, but mainly because of the results of what has been termed 'the desiccation of Africa.' Many reasons have been propounded for this, but the most probable is that these climatic forests originated here when the climate was more moist and when the coast-line was farther north than it is now, and they are now very near their dry climatic limit."

The rain forest is generally limited by the 70-inch rainfall line; it passes gradually into a deciduous forest (about 75 per cent of the trees shed their leaves in the dry season) with fringing forest along the streams. The northern boundary of the

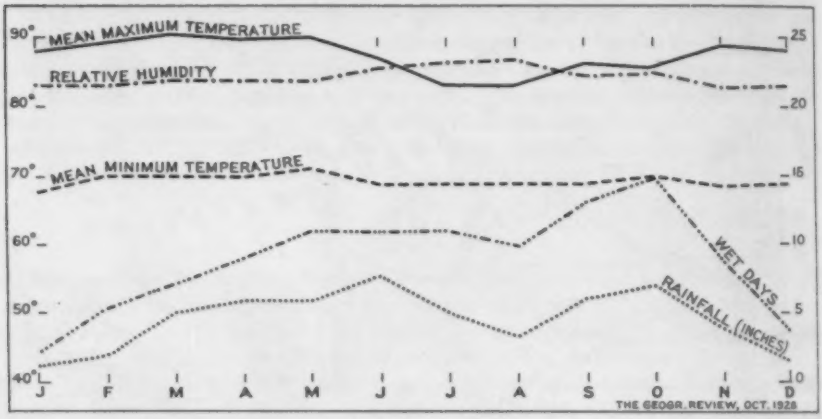

FIG. 2—Ideal climatic chart of typical closed forest region of the Gold Coast, redrawn on a different horizontal scale from Figure 19 of Mr. Chipps' memoir. Temperature scale in °F. on left; inches of rainfall and number of rainy days on right. Note the abatement of rains in August, equable temperatures, high and constant relative humidity.

deciduous forest, about the 50-inch rainfall line, is abrupt. The savana formation to which it gives place seems to be an artificial creation, a secondary growth replacing former woodland where repeated burnings have destroyed the original cover. Grassland at present occupies only a small area in Southern Nigeria, though it is likely to increase. It occurs on exposed heights, notably on the Udi Plateau (1200 to 2000 feet), where drainage is rapid and evaporation excessive.

Mr. Chipp, who is the author of the chapter on tropical countries in the useful handbook "Aims and Methods in the Study of Vegetation" (London, 1926), makes a special analysis of climate in relation to the Gold Coast forest and publishes a series of climatic graphs including a type graph which, drawn on a different horizontal scale, is here reproduced. The vegetation of the country is classified as closed forest and parkland (this term preferred to the rather vague "savana") with maritime vegetation as an edaphic formation.

He describes the closed forest as a product of the "Guinea" climatic belt, in the Gold Coast modified to a "distinctly anomalous type," a monsoon climate. Rainfall is greatest immediately behind the shore line trending north of west to south of east and diminishes northeastward. The southwestern aspects of the local relief lying across the track of the southwest monsoon contrast with the much drier northeastern aspects. The 2000-foot Kintampo-Ejura escarpment marks the northern limit of the forest. Parkland is the product of the "Sudanese climatic" zone. Soil here plays an important part; the predominance of sandstone and of hard laterite surfaces is associated with low ground water. In this paper parkland is considered only in its relation to the closed forest on the northern, southern, and eastern borders of which, thanks to man's intervention, parkland is encroaching.

The Economic Transformation of the Gold Coast. In "The Economic Revolution in British West Africa" (London, 1926), Mr. Allan McPhee justifies the use of the term "revolution" by the suddenness and radical nature of the changes that have taken place in this region the last forty years. In the Gold Coast this transformation has assumed a special form, the dominant cocoa industry, which even the sober Parliamentary Report describes as "little short of a romance" (Report by the Hon. W. G. A. Ormsby-Gore, M. P. (Parliamentary Under-Secretary of State for the Colonies), on his Visit to West Africa during the Year 1926, Cmd. 2744, 1926).

In 1879 a Fanti laborer succeeded in smuggling some cocoa pods from the jealously guarded plantations of Fernando Po into the Gold Coast Colony. His plantings prospered. One of the West Coast missions took up the new cultivation. Then the Government became interested. In 1891 the first shipment of 80 pounds of cocoa was made from the colony. In 1926, 231,000 tons were exported (L. J. Schwarz: Cocoa in West Africa, *U. S. Dept. of Commerce Trade Promotion Ser. No. 68*, 1928). The Gold Coast has become the major cocoa-producing country of the world. As an economic romance the industry is comparable with that of rubber or quinine in southeastern Asia and Malaysia. But, unlike the greater part of these introduced cultivations which are European-owned plantations, the cocoa cultivation of the Gold Coast is entirely in native hands. (In recent years there has been a tremendous increase in the number of native-owned rubber plantations in Java.) Native control is a policy applied not only to cocoa in the Gold Coast but to all agricultural resources in British West Africa: only minerals are being developed by the foreign capitalist. The policy is unique, and it furnishes a particularly striking contrast with conditions on the other side of the continent. Mr. McPhee suggests some of the contributing causes to this differentiation of policy: the sudden contact of European and native civilization in East Africa as compared with the old established relations in the West, the dominance of pastoral economy, and a climate better suited for the white man. The change from a "natural" to a "monetary" economy is bringing a host of other changes in its train to the natives of the Gold Coast. Land is becoming a commercial commodity, and there is a weakening of the old communalism and tribal authority.

But the success of the natives on their little cocoa farms would not have been possible without governmental aid, both as regards agricultural processes and marketing. Growth of the industry is closely related to growth of transportation facilities. The Gold Coast is naturally poorly endowed with waterways and harbors. The Report on Economic Agriculture for 1889 said "The only available beast of burden is man, the weakest and most costly of all." The country now has three railroad lines, 475 miles in all (Gold Coast, Rept. for 1926–27, *Ann. Colonial Repts. No. 1386*, 1928). Western and eastern lines converge on Kumasi from Sekondi, passing through the gold and manganese fields, and from Accra, through the main cocoa district; a central line has recently been opened. In the last seven or eight years the Government has been very active in road construction. Mileage of roads practicable for motor vehicles is 4690. The "Layered Road Map of the Gold Coast" on the scale of 1:500,000 (1926), published by the Survey Department, is an instructive document.

Deficiencies in interior transport being thus made good, attention has been turned to the construction of an adequate port on this surf-bound coast completely lacking in natural harbors. A site was found in Takoradi, a short distance southwest of Sekondi. The new deep-water harbor was formally opened in April, 1928. An official description, "Takoradi Harbour and Railway Terminus, 1921–1928" has been issued in commemoration of the opening. The comments of the French press are illuminative: "un événement capital qui ne saurait laisser indifférents ceux qui s'intéressent aux colonies du Golfe de Guinée" (La Gold Coast et le port de Takoradi, *Renseign. Colon.* (*Suppl. à l'Afrique Française*), 1928, pp. 320–326)—with the exception of Dakar the ports of French West Africa are poor.

The future of the Gold Coast's great industry has caused some concern; fears

have been expressed that the maximum development has been reached. There has been some falling off of productivity in the eastern area. Herein lies one of the weaknesses of the present system: the agricultural education of the native still has a long way to go. The larger part of the area of suitable land with the requisite amount of properly distributed rainfall (for a rainfall map see G. G. Auchinleck: Seasonal and Geographical Distribution of Rainfall in the Gold Coast, *Gold Coast Rev.*, Vol. 2, 1926, pp. 28–33) has been brought under cultivation, though there is available some land at present sparsely populated in the west and northwest of Ashanti. One phase of the problem that is causing worry to the administration is the deforestation that continues apace. "It is almost impossible to persuade the native that it is essential for the future of the crops and the water supply of his country that certain forest areas should be maintained. Practical difficulties arise from the unsettled state of the tribal administration, due to the frequent destoolment and deaths of the Chiefs, and also to inter-tribal friction, and the complexity of the land problem." This is the other side of the picture of native policy in British West Africa.

ASIA

Two Recent Geographical Studies of Rural India. The British have brought more than law and order to India. The elements of Western civilization introduced by them have modified Indian economic life in nearly all its aspects, rural and urban alike. Some of these modifications have been for the better, as in the case of the Deccan peasants. In the old days each Deccan village, "cut off from outside intercourse, was entirely dependent on its own production for its existence. Should the rain, upon which the crops depended fail, then starvation and death were the result, and it was not an infrequent occurrence on the Deccan. . . . Into this land of villages came the West, with its roads and railways, its irrigation works, and its commercial and scientific farming, perhaps to darken the bright side of the picture, but certainly to brighten the dark side" (Ethel Simkins: The Agricultural Geography of the Deccan Plateau of India, *Geogr. Teacher Suppl. No. 2*, London, 1926, pp. 72–73).

On the other hand the coming of "the West" has not always brought even material prosperity. This is shown in a recent study by Arthur Geddes, "Au pays de Tagore: La civilisation rurale du Bengale occidental et ses facteurs géographiques" (with preface by A. Demangeon; Paris, 1927?). In western Bengal the construction of railways has been the principal factor in modern times leading to widespread deforestation. The all too familiar results have followed the cutting down of the jungles: sudden floods, accelerated erosion of slopes, and silting of streams. For flood protection dikes have had to be built along the lower courses of the rivers that flow across the deltaic plains. Thus the rice fields no longer receive the benefits of the mud with which the floods formerly renewed their fertility, and no longer are the stagnant pools on the low lands periodically purged of the malarial scourge by the health-bringing flood waters. Mr. Geddes asserts: "In a word, the deforestation of the high grounds certainly seems to produce famine and mortal fever on the plains." It does not take very much in India to upset the delicate adjustment of man to nature.

The two publications cited above make clear the critical closeness of this adjustment. Miss Simkins brings out the relations between topography, soils, and rainfall on the one hand, and crop production, settlement, rural economy, and distribution of population on the other. In general the soils of the Deccan fall into two main groups: the regur, or black soils due to "subaerial weathering of either trap or metamorphic rock," and red soils, "overlying the metamorphic rocks of the Southern and Eastern Deccan, outside the trap area." On the regur soils jowar and bajri (varieties of millet), with cotton, are the main crops: the red loams are the rice-growing areas. In the jowar-bajri-cotton zones commercial agriculture has been most extensively developed; the rice areas, although they show commercial influences

"as yet only slight," have the densest population. Although the land throughout most of the Deccan is tilled by small proprietors, in a small coffee-growing region along the edge of the Western Ghats "the majority of the coffee estates are owned and run by Europeans and worked with native labour . . ."

In conjunction with Miss Simkins' study reference may be made to a paper by J. N. L. Baker, "Notes on the Natural Regions of India," in the Summer, 1928, number of *Geography*. In the Deccan he recognizes as the major subdivisions the northwestern trap area of millets and cotton and the southern area of "rice and tanks."

Arthur Geddes is the son of Professor Patrick Geddes, founder of the Outlook Tower in Edinburgh, "a museum of civic geography with a world outlook" (*Geogr. Rev.*, Vol. 12, 1922, p. 432). The spirit of the Outlook Tower has been carried by the son into his present study. As Professor Demangeon writes in the introduction, Geddes "has made himself thoroughly acquainted with the Hindu spirit, even through contact with the great poet, Rabindranath Tagore." Geddes passed more than six months in the "sanctuary of Hindu intelligence and patriotism" that has been built up by Tagore some hundred miles northwest of Calcutta.

The Uriankhai Basin as a Border Region. A clear conception of the Uriankhai Basin as a Siberian-Central Asian border region is given by H. Hausen in a paper on the physiography of the Upper Yenisei drainage area. The Uriankhai Basin is the gathering ground of the upper waters of this great Siberian river. The basin is surrounded by mountains of "quite uniform physiognomy: flat-formed upland surfaces of general heights about 6000 feet and slopes dissected by narrow, rapidly descending valleys." On the north is the West Sayan chain which passes eastward and westward into ranges of snow-clad alpine peaks. On the south are the block mountains of the Tannu-Ola (the author spells "Tangnu-Ula" as approximating nearer the Mongolian pronunciation), which thus forms part of the hydrographic divide between the Arctic Ocean and the Central Asian area of interior basin drainage. The Uriankhai Basin, which occupies 150,000 square versts (about 65,000 square miles), is a depression of a Central Asian type, but it has an outlet to the north in the great S-shaped gorge of the Yenisei, "a remarkable hydrographic anomaly." There is a sharp contrast between the perfect drainage of the basin and the Northwest Mongolian Lakes region on the other side of the Tannu-Ola.

FIG. 1—Map to show the location of the Uriankhai Basin between Siberia and Outer Mongolia. Scale approximately 1:23,000,000.

The Tannu-Ola is forested on the northern slopes but is much drier than the northern mountains. Mr. Hausen considers that the West Sayan chain may be regarded as "the real divide between the humid mountainous *taiga* region of the Southern Siberian and the Mongolian steppes." On the vegetation of the Sayan area he mainly follows the excellent work of Henrik Printz (The Vegetation of the Siberian-Mongolian Frontiers (the Sayansk Region), Trondhjem, 1921). Printz recognizes four main phytogeographical divisions in the West Sayan: subalpine *taiga* or forest on both sides of the mountains; an alpine region above the tree line; a steppe area (Central Uriankhai steppe) of Mongolian or Central Asiatic stamp; a transition between *taiga* and steppe. He expresses the opinion that the steppe is gaining on the forest as a result of desiccation.

The native population is a mixed Mongolian tribe, called by the Mongols "Uriankhai," by the Russian "Soyoty." It is estimated that there are 40,000 of them living north of the Tannu-Ola, a boundary which Chinese and Mongolian authorities will not permit these seminomads to pass. The region has seen a considerable Russian emigration, first of gold seekers and merchants, of true settlers since the beginning of the present century. In 1912 as a result of the Russo-Mongolian treaty the region came under Russian protection, and colonization was more closely organized. An administrative center was set up at Bielotsarsk, and a survey of natural resources commenced. The civil wars of 1918 and 1919 brought chaos. For a short time following the cancellation of the autonomy of Outer Mongolia in 1919 the area again came under Chinese suzerainty, but on Soviet occupation of Urga it proclaimed its independence as the "Tannu Tuva Republic." Protests have been made by both China and Mongolia, but no settlement seems to have been reached; and meanwhile, according to the China Year Book for 1928 (pp. 377–378), "the 'Tannu-Tubin Republic' maintains direct relations with the U. S. S. R., a new telegraph line connects its chief populated center, Krasny (formerly Bielotsarsk) with Russia, and measures, similar to those inaugurated in Outer Mongolia, are being taken to strengthen the link between this region and Siberia." Apparently the independence of the Republic is recognized by Mongolia for it is shown without the boundaries of that country in the latest political map of Mongolia (1928, scale 1:2,000,000) put out by the Mongolian Minister of Education (described in the *Zeitschr. Gesell. für Erdkunde zu Berlin*, No. 7/8, 1927, pp. 429–430).

Mr. Hausen's paper is a part of a report which he has edited on a geological expedition to the Siberian-Mongolian frontier (1917–1920) organized and directed by Professor J. J. Sederholm of Helsingfors. The report also includes a historical review of the scientific work in the area and detailed geological observations on the itineraries of the parties of the expedition. It is published in the first number of *Acta Geographica*, a series inaugurated by the Geographical Society of Finland to deal with research on foreign lands in contradistinction to *Fennia*, which is devoted to the home country.

AUSTRALASIA AND OCEANIA

Problems of Tahiti. "Tahiti deserves to be highly regarded by physiographers, for it has been suggestive of new physiographic ideas to various visitors," says Professor Davis in describing the island as a physiographic type (The Coral Reef Problem, *Amer. Geogr. Soc. Special Publ. No. 9*, 1928, p. 259). This view is endorsed by Dr. Cyril Crossland, who indicates the scope of the problems that remain. "Tahiti has a real value to mankind in its history, geological, anthropological and social. Its geological story may yet, by affording the simplest case, give a clue of value to the puzzle of the coral reefs of the world" (The Island of Tahiti, *Geogr. Journ.*, Vol. 71, 1928, pp. 561–585). He gives a graphic account of both the border of the island and the interior with its striking conformation and vigorous growth of mountain vegetation, "stronger than what I recollect in the forests of Panama." The knife-edged ridges so characteristic a feature of the topography and "high cliffs at the heads of valleys with slender waterfalls after rains," he thinks, have been determined in large part by subterranean drainage and consequent landslides, "the result of rock structure peculiar to volcanoes which have reached this state of decay in the tropics, viz., the alternation of lava sheets of very different strengths, some of which have decayed more or less into clay." The significance of great porosity of the rock under similar conditions is pointed out by Chester K. Wentworth in a paper entitled "Principles of Stream Erosion in Hawaii" (*Journ. of Geol.*, Vol. 36, 1928, pp. 385–410), in which he lays stress on the underground drainage and on the relative importance of chemical as compared with mechanical erosion.

As regards the coral reef problem Dr. Crossland's views are opposed to those of Professor Davis. Where the latter sees subsidence and coral growth, the former sees reef decay. He denies the existence of the embayed valleys advanced by Davis in proof. As Professor Stanley Gardiner points out in the discussion of Dr. Crossland's paper, a further critical study of these valleys is desirable. Professor Setchell, who has studied the coral reef problem in Tahiti (Phytogeographical Notes on Tahiti, *Univ. of California Publs. in Botany*, Vol. 12, 1926), states in *Science* for August 10, 1928, his belief that all types of reef "not only may, but do, develop to their full expression under still-stand conditions of ocean level."

Dr. Crossland relates the question of the Tahitian reefs to the human history of the island. Where the reefs are absent the maritime flat which otherwise borders the island is absent: and the flat is the basis of Tahitian life, on it grow the staple crops. "Where the process [of reef decay] has gone farthest, on the northeast coast, the island is desert, but in many other parts the flat is reduced to a mere fringe of palms, almost without human habitations." As it is, the status of the Tahitians leaves much to be desired. According to Dr. Crossland the present population, native and half caste, numbers only about 5000; they are even now being supplemented by the hardier Chinese "who alone have the energy to cultivate the barren slopes above the cliffs, and some of the less forbidding valleys."

The asset of splendid reef-bound harbors is not capitalized. The strategic advantage of Tahiti has indeed long been realized. As long ago as 1846, when the Panama Canal project was first seriously mooted, the Legislative Council of New South Wales investigated the route via Tahiti (G. H. Scholefield: The Pacific, Its Past and Future, New York, 1919). The needs of the case are urged by L. G. Numile in *L'Économiste Français*, February 11, 1928. He discusses the rival merits of Papeete and Port Phaeton (Taravao Bay), favoring the latter with better shelter and adequate space for the utilities necessary in a great port.

POLAR REGIONS

Sub-Antarctic Islands. Very different conditions prevail south of latitude 40° S. from those existing in similar latitudes in the northern hemisphere where the large continental masses enjoy a climate generally termed "temperate." The southern extension of South America and the poorly defined Antarctic Continent are the sole large land masses. There are, however, a number of small isolated islands: Marion, Crozet, Kerguelen, St. Paul, and Amsterdam islands under the French Flag; and the Falkland, Sandwich, South Georgia, and South Orkney islands grouped into the Falkland Dependency of the British Empire. Bouvet Island lies midway between these two groups. Shrouded in mists and storms, with low temperatures and few days of sunlight, these islands present conditions very unfavorable for the development of life. In striking contrast the surrounding seas support a rich fauna and flora. Whales, seals, sea lions, and innumerable varieties of fish swarm in the waters, while sea birds are very numerous. On the islands elevation, cold, and high winds preclude tree growth; and the vegetation, sparse and of few varieties, is largely confined to the littoral. The few native animals have been supplemented by introduced species such as goats, pigs, rabbits, and rats, in some cases adversely affecting the flora, barely capable of holding its own against the unfavorable environment (Camille Vallaux: La vie dans les petites îles australes, *Bull. l'Inst. Océanogr. No. 512*, March 15, 1928, Monaco).

Although these islands have been known for over two hundred years, only one group, the Falklands, has been colonized. Sheep raising, the basis for the successful colonization of the Falklands, is being attemped on Kerguelen Island with indifferent success (*Geogr. Rev.*, Vol. 17, 1927, p. 498). At present the sea life of the area constitutes its sole economic importance. Seals have been almost exterminated

by the numerous drives against them; whaling is now the most lucrative occupation, and ships of many nations may be found in these waters.

The whaling industry has been the cause of some very interesting developments in the region. Having in mind previous depletions of whaling grounds, and with an eye to the conservation of the industry, the British have assigned two ships to a systematic study of the situation. The report for the first year's work ("*Discovery* Expedition: First Annual Report, 1926," London, 1927; Stanley Kemp: The *Discovery* Expedition, *Nature*, No. 2974, Vol. 118, 1926, Oct. 30, pp. 628–632) describes the work accomplished in the neighborhood of the Falklands and South Georgia. In connection with a study of the feeding habits a valuable study of the plankton was carried out. A marine station was established, and 738 whales were examined. In 1927, with the addition of the second ship, the *William Scoresby*, six lines of plankton stations were made between Cape Town and the Falklands (Stanley Kemp, The *Discovery* Expedition, *Nature*, No. 3055, Vol. 121, 1928, May 19, pp. 795–799).

Norwegian whalers who, although they almost monopolize the industry in certain localities, are forced to obtain most of their concessions from Great Britain, have also been active in exploration and in search for new whaling grounds. Heading towards the southern Pacific from South Georgia, Eyvind Tofte in the *Odd I* in January, 1927, located Peter I Island. This tiny islet, five miles in width by eight miles in length, was discovered by Bellingshausen in 1821 and later seen by Charcot in 1910. It was not found possible to make a landing, but the Norwegian expedition photographed the island from all sides (Charles Rabot: Une reconnaissance dans l'Antarctique: l'île Pierre Ier, *La Nature*, No. 2768, Sept. 1, 1927, pp. 220–221). A description of the island, nine-tenths of which is covered by snow or ice, is given by Eyvind Tofte in *Norsk Geografisk Tidsskrift* (Vol. 1, 1927, pp. 462–472).

The following season Lars Christensen, backer of the *Odd I* Expedition, outfitted the *Norwegia* for exploration along Enderby Land. In December, 1927, the expedition landed upon Bouvet Island, where a stay of almost a month was occupied in whaling, sealing, and scientific studies. During the cruises around Bouvet Island the *Norwegia* struck a rock, and the trip to Enderby Land had to be postponed in order that repairs might be made. Subsequently two of the scientists, Prof. Holtedahl and Dr. Olstad, made collections in the South Shetland Islands.

An international complication has arisen from this last expedition. The Captain of the *Norwegia* on landing took possession of Bouvet Island in the name of Norway. At the same time the British Government announced the lease of the whaling rights to the island to a Norwegian whaling concern. Great Britain bases her claim on the fact that an English whaler named Morris landed on what he called Liverpool Island and took possession of it in the name of King George IV. Discovered by Lozier Bouvet in 1738, this island eluded the attempts of Cook and Ross to relocate it. Meanwhile Morris and other whalers discovered Liverpool, Lindsay, and Thompson islands in the vicinity. Finally the German *Valdivia* Expedition in 1898 relocated Bouvet Island but at considerable distance from the position given it by its discoverer. The consensus of opinion is that all these islands are the one Bouvet Island which Great Britain claims because of the act of Morris. Norway, on the other hand, claims that if Liverpool and Bouvet islands are one and the same, Great Britain has neither colonized the island nor, as in the case of her other Antarctic possessions, issued any "Orders in Council" proclaiming her sovereignity ("The *Norvegia* Expedition and Bouvet Island," by Consul Bjarne Aagaard, Oslo, 1928). The matter is still under discussion (Charles Rabot: L'île Bouvet, *La Nature*, No. 2784, May 1, 1928, pp. 387–389; *Current History*, Vol. 27, 1928, p. 907).

Nature for March 31, 1928, states that Lars Christensen has decided to establish a radio and meteorological station on Bouvet Island. Such a step would be important in the scheme for establishing sub-Antarctic meteorological stations to supplement that on the South Orkneys taken over by the Argentine Meteorological Office.

THE OCEANS

The Greatest Ocean Depth. For the past decade and a half the greatest known oceanic depth was that found by the German surveying ship *Planet* in 1912 about 40 miles east of the island of Mindanao, Philippine Islands, where a sounding by wire gave a depth of 9788 meters, or 32,113 feet. A still greater depth was found last year in this region by the German cruiser *Emden*. The *Nachrichten für Seefahrer* for May, 1927 (p. 465) reports the discovery by the *Emden* of a depth in excess of 10,000 meters. Since the *Emden* employed an echo-sounding apparatus, the exact depth depends on the value taken for the velocity of sound in sea water, which depends on the temperature, salinity, and pressure of the column of water through which the sound is transmitted. Adopting the most probable values for these variables, H. Maurer derives the depth found by the *Emden* to be 10,793 meters, or 35,410 feet (*Zeitschr. Gesell. für Erdkunde zu Berlin*, 1927, p. 340). This depth was found about ten miles southeasterly from the *Planet* depth. Maurer reports further that the *Emden* made several hundred soundings in that region, of which 46 gave depths in excess of 10,000 meters.

H. A. MARMER

MATHEMATICAL GEOGRAPHY

A Rapid Method of Determining Position at Sea. It is universally agreed by navigators that two observations are necessary in order to get a fix at sea. There is no exception to this rule nor ever can be. In the middle of the day in summer time two observations of the sun, separated by about two hours, will frequently give two Sumner lines which intersect at a large angle and thus give a satisfactory fix. At dawn and dusk a planet may be useful; and after dark two stars suitably placed, when the horizon is visible, will permit two observations for the same purpose. The books also give as a special case an observation on the prime vertical for a body very near the prime vertical, by which latitude and longitude may be secured at the same time but not in a single observation, one observation being for altitude and the other for the rate of change in altitude.

Mr. Edward J. Willis, author of the excellent volume "The Methods of Modern Navigation" (New York, 1925), now comes forward with an appendix to this volume under the title "The Line of Azimuth" (1928), presenting a method of securing a fix within a comparatively brief time by means of a Sumner line and the line of azimuth, the latter being based upon an observation of the rate of change in altitude of the observed body.

This method differs radically from the process on the prime vertical and is asserted to be available except when the object is near the meridian. It is, of course, a fact that the rate of change of altitude for any given latitude is dependent on the azimuth of the body, and the rate may vary from zero to not exceeding one minute of arc in four seconds of time.

The Appendix shows mathematically how, given the altitude and the rate of change of altitude of any celestial body, the observer's position is definitely established; and a short and simple equation is given for the observer's latitude, containing only these two quantities and the object's declination. There is also given a similar equation for the observer's hour angle from the object and hence the observer's longitude. The two formulae are easily worked, and the reader need not fear coming into relation with the calculus; for, although in the establishment of the equations the dubious quantity dA/at occurs, the calculus for practical purposes ceases at this point, and from there on the calculation for position deals only with the long-familiar logarithmic sines, cosines, tangents, etc. of altitude declination, latitude, hour angle, etc. Even the dubious quantity dA/at need not be greatly feared, for it is only a short

name for the rate of change of altitude, i. e., in plain English, a fraction with a few minutes of arc for the numerator and a few minutes of time for the denominator.

The method set forth by Mr. Willis is almost wholly dependent on the rate of change of altitude, which is not nearly as easy to observe as altitude. This is almost the only serious objection that can be offered. In 1853, Prestel showed that latitude could be obtained from the rate of change of altitude, when the object was on the prime vertical, and made use of the sun's known diameter in minutes as the numerator of the fraction above referred to. Mr. Willis extends this method to any azimuth and thus makes it general and available at all times except near the meridian when, of course, the usual meridian calculation for latitude should be used. It is really the quickest way known to obtain a position at sea and on this account may be of vital service in emergency, for the two observations require only three or four minutes in summer and six or eight in winter, and the calculation is short and easy. The only difficulty is that conditions must be favorable and the observations must be carefully taken to obtain good results in so short a time.

To get greater accuracy, Mr. Willis offers also a method of obtaining the rate of change of altitude from the difference of three altitudes taken at equal intervals of from fifteen minutes to half an hour, as the observer deems advisable. In summer about fifteen minutes gives excellent results, and in winter about half an hour. In practice the third observation is actually made up from two observations made just before and just after a calculated time. Prestel's method of observing the rate of change of altitude will, together with Mr. Willis' equation for latitude, give a position always on the Sumner line but not the exact place on the line. The three-altitudes method gives the observer's position on the line with accuracy, assuming, of course, the work to be properly done.

As to the accuracy of the results obtainable, the author has expressed the opinion that, under favorable circumstances and by the use of the quicker and less accurate method, the ship should be within five miles of the fix obtained. If the Sumner line problem is also worked, this would narrow the space of uncertainty to a width of a mile or two on each side of the line.

If, on the other hand, the more accurate method, also given in the pamphlet, is used, requiring from half an hour to an hour in observing, the probable error would be appreciably less, varying considerably, of course, with the skill of the navigator in making the observations.

The importance of using the line of azimuth obtained by either method lies in the fact that a fix may be obtained by means of it which could not be had in any other manner and which may be of vital importance. It would seem, therefore, that the navigator cannot afford to be without a knowledge of the new method given in this pamphlet. It can be obtained for 25 cents from the publisher, R. Massie Nolting, P. O. Box 411, Richmond, Va.

CHARLES E. MANIERRE

PHYSICAL GEOGRAPHY

The Problem of Past Climates. In an admirably frank and instructive paper G. C. Simpson treats three important problems of past climates (*Quart. Journ. Royal Meteorol. Soc.*, Vol. 53, 1927, pp. 213–232). These problems are the supposedly subtropical temperature in the polar regions and the slight difference of temperature between equatorial regions and polar regions during long periods of the earth's history; the last ice age; and the former existence of glaciers at sea level within the tropics.

The view that the assumed uniform climate in the northern hemisphere was due to vast oceanic currents carrying warm water to the polar regions is based on an entirely wrong conception of the physical causes which maintain the existing climatic

zones. Great quantities of heat and cold are transported by the general air circulation from equatorial regions to polar regions, and vice versa. Other large quantities of heat and cold are carried by the ocean currents, which, driven almost entirely by the wind, are dependent on the intensity of the general circulation of the atmosphere. This latter, however, depends for its energy on the difference of temperature between equatorial regions and polar regions. There are thus two opposing factors, viz. (1) the temperature difference which induces the general circulation and (2) the general circulation which tends to eliminate the temperature difference. Hence, and because of the inertia and other properties of the atmosphere preventing complete equalization of temperature, the final results of new warm currents to the polar regions would be little or no change of temperature. There must always have been temperature zones similar to those which exist today.

The temperature gradient between the equator and the poles and the average temperature of the zones are found to be largely independent of the distribution of land and sea. But, while the nature of the earth's surface plays a small part in determining the average temperature of a zone, it plays a large part in determining the actual temperature in various parts of the zone. Thus, the temperature is highest over the east of the oceans, because the chief transport of warm air from equatorial regions takes place here; and it is lowest over the east of the continents, because the return flow of air from the polar regions mainly occurs here. The magnitude of the induced difference is limited; the highest temperatures over the North Pacific Ocean are within 3° C. of the highest temperature in the narrow North Atlantic with its Gulf Stream; and the lowest temperature of any latitude over North America is almost exactly the same as the lowest temperature on the same latitude over Asia, which is more than twice as broad.

With another distribution of land and water and other ocean currents we should have the same average temperature. Greater variations of temperature than at present are not easily conceivable. Therefore it seems that at no time in the past is even a limited region of the earth's surface north of latitude 40° likely to have had a higher or lower mean annual temperature than can be found somewhere on the same latitude today. The same limits of temperature would obviously apply to the southern hemisphere also.

If, then, readjustment of land and sea would not alter the mean temperature of the zones, can the Quaternary glaciation have been caused by increase of the land area or by raising of the land surface? The answer is no.

The Greenlandic ice sheet is for the most part more than 1000 meters high. Greenland on the east and the west is bathed by cold oceanic currents which produce very low summer temperature. The conditions for ice formation in Greenland are thus extremely favorable in comparison with what they would be on an uplifted Scandinavia. Since, furthermore, the Greenlandic ice is a relict from the last glaciation which just balances supply and wastage, how could an ice sheet form in Scandinavia?

Can glaciers at sea level within the tropics be brought about by any arrangement of land and water? The answer is no.

In the high Himalayas the snow line lies about 5000 meters above the sea, and the glaciers terminate above the level of 3000 meters. As the normal fall of temperature with height is 6° C. per 1000 meters, a temperature fall of more than 18° C. would be necessary if temperature were the only factor. A general temperature fall as cause is out of the question, since the temperature of the zone is fixed so long as solar radiation and the nature of the atmosphere remain unchanged. A sufficient local temperature fall by a redistribution of land and water is inconceivable. Within the equatorial belt the lowest mean temperatures are met over the sea. The coldest spot in the tropics at present, which is produced by a cold ocean current off the coast of Chile, has a temperature of 18° C., i. e. 16° C. above the maximum temperature deduced to be allowable if the glaciers of the Himalayas are to expand to sea

level. Increased snowfall cannot be the cause, since it is difficult to conceive of any conditions more favorable for snowfall than those existing in the Himalayas.

Thus, "meteorology is unable to offer a solution of the three main problems of past climates," though "a consideration of them led an eminent meteorologist [Köppen, in Köppen-Wegener, "Die Klimate der geologischen Vorzeit"] to point a way out."

ERNST ANTEVS

HUMAN GEOGRAPHY

Railway Zone Pattern As an Indication of Economic Development. Professor Jefferson illustrates his paper, "The Civilizing Rails" (*Econ. Geogr.*, Vol. 4, 1928, pp. 217–231) with a striking series of black-and-white maps of the continents. On a black ground is shown the "useful neighborhood" of the railway by a white band, arbitrarily selected as within a distance of ten miles. Certain distinctive patterns may be recognized in the arrangement of these "bands of mobility"—the "web," the "net," the "tentacle," the "river link," corresponding to certain stages of economic development of the regions concerned. The rail web is a white patch produced by overlapping bands, where "the lines and threads of communication are lost in one great fabric of easy transportation, extended and continuous." Such obtains in western Europe, exclusive of the Scandinavian uplands and the Iberian Peninsula; in eastern North America as far west as the 100th meridian, an aridity barrier (less than 20 inches of rain) and into Canada south of the Canadian shield. On the Argentine pampa there is a smaller web, also limited westwards by an aridity barrier (less than 20 inches (550 mm.) of rain: this is discussed by Franz Kühn in "Capitulos de Geografía económica Argentina, *Anales de la Facultad de Ciencias de la Educación*, Universidad Nacional del Litoral, Paraná, Vol. 3, pp. 65–99, 1928) and incipient webs about Rio de Janeiro and São Paulo.

The separate bands appear in the rail net. Examples are seen in Spain and Portugal, Russia, and the Balkans. In Russia the strands show an interesting "cobweb" effect (compare Fig. 10, p. 636 of this *Review*), as for instance around Moscow, resulting from facility of construction on the plain together with planning by central authorities, a pattern of "autocratic rule." The rail web of North America is continued westward to the Pacific and south through Mexico by a rail net. The Atlas region, South Africa, and southeastern and southwestern Australia have rail nets. In the vast extent of Asia only Japan and India have progressed so far. "Nothing could put England's contribution to the civilizing of India in a clearer light than this map of the Indian rail net with its thickening in the valley of the Ganges."

Beyond the rail net stretches out the railway tentacle. North American examples are the line to the Peace River District and the line now building to Hudson Bay, to the new terminus at Fort Churchill (see F. Palmer's "Report on the Selection of a Terminal Port for the Hudson Bay Railway," October, 1927), replacing Port Nelson. Most of South America's railroads are essentially of the tentacle type. The longitudinal railroad of Chile, for instance, was built primarily for strategic purposes; economically it is the branches from the sea that are important. The Russian railways in Asia are striking examples of tentacular development. The river link type is characteristic of undeveloped regions where rivers are the main highways. The line around the Madeira Falls in Amazonia is one of several examples from South America.

GEOGRAPHICAL NEWS

Memorial to Lieutenant Commander George W. De Long. A memorial to Lieutenant Commander George W. De Long, the heroic leader of the ill-fated expedition of the *Jeannette*, 1879–1881, and to the officers and men of his command was unveiled on July 4 at Woodlawn Cemetery, New York. The ceremony took place in the

presence of Mrs. De Long and a number of explorers who had gathered to pay tribute to his memory. The act of unveiling was performed by Lieutenant De Long Mills, a grandson, and Mr. Herbert Wood Leach, only survivor of the *Jeannette* expedition now living. Captain Sir Hubert Wilkins, Vilhjalmur Stefansson, and Anthony Fiala spoke of the value of the work accomplished on the *Jeannette* during its long drift in the Arctic pack, precursor of Nansen's drift in the *Fram*. General Greely has summarized the achievements thus: "Apart from valuable physical observations in an unknown region, the geographic results of this expedition were extensive and important. They covered some 50,000 square miles of polar ocean, and clearly indicate the conditions of an equal area between their line of drift and the Asiatic coast. De Long proved that the Siberian Ocean is a shallow sea, dotted with islands . . ." (A. W. Greely: A Handbook of Polar Discoveries, Boston, 1909, p. 192).

OBITUARY

Dr. Otto Nordenskjöld. Dr. Otto Nordenskjöld, professor of geography at the University of Göteborg, died in Göteborg on June 2, at the age of 58. Dr. Nordenskjöld's contributions to polar geography are very great, both in his investigations of specific problems, as for instance, his glaciological studies in Greenland and the Antarctic, and in his power of broad synthetic generalizations, as exemplified in his work "Polarnaturen" (Stockholm, 1918), of which an English version, "Polar Nature: A General Characterization," forms part of "The Geography of the Polar Regions" (*Amer. Geogr. Soc. Special Publ. No. 8*, 1928). Dr. Nordenskjöld early followed in the steps of his distinguished uncle, Baron A. E. Nordenskiöld, the first to accomplish the Northeast Passage. In 1895 he organized an expedition to the Magellanic lands for geological, botanical, and zoölogical study (Wissenschaftliche Ergebnisse der Schwedischen Expedition nach den Magelländern, 1895–1897, 3 vols., Stockholm, 1905–1907). Immediately on his return he engaged in plans for Antarctic research, a subject which then, thanks largely to the interest roused at the International Geographical Congress of 1895, was attracting international attention. Nordenskjöld's efforts materialized in the Swedish South Polar Expedition, 1901–1903, whose base was established on the east coast of Graham Land. In the rich harvest of scientific results (Wissenschaftliche Ergebnisse der Schwedischen Südpolar Expedition, 1901–1903, 7 vols., Stockholm, 1908–1921) particular interest attaches to the observations pointing to the former connection between Graham Land and the South American continent. A popular narrative of the expedition in English, "Antarctica," appeared in 1905.

The polar regions continued to exercise their "mystic force" on the explorer, and later years found him in collaboration with English friends for an "Anglo-Swedish Antarctic Expedition," of which he was to be leader and which was to have taken place in 1915. It was frustrated by the war; but both before and after this interruption he visited various Arctic regions, Greenland ("On the Geology and Physical Geography of East Greenland," *Meddelelser om Grönland*, Vol. 28, 1908), Spitsbergen, and Iceland, enriching his store of knowledge of that polar nature, which is "not so strange," he himself said, "for those who live in northern countries."

Mention must also be made of Dr. Nordenskjöld's interest in South America. In 1920–1921 he again visited that continent, traveling through Chile and Peru. One phase of the geography of these lands that attracted his attention was the problem of foreign colonization. His views are contained in his work, "Sudamerika: Ein Zukunftsland der Menschheit," Stuttgart, 1927.

GEOGRAPHICAL REVIEWS

Industrial North America

Sten De Geer. **The American Manufacturing Belt.** Maps, ills. *Geogr. Annaler*, Vol. 9, 1927, pp. 233–359.

American geographers will be glad of this admirable work of the well-known Swedish geographer, in great part the result of his visit to this country in 1922.

He outlines our great industrial region as the southern three-quarters of the New England, Middle Atlantic, and eastern North-Central States, omitting the coastal islands and peninsulas. His criterion of industrial activity is the number of wage earners in a city, which the census enumerates for all cities of 10,000 or more inhabitants. His main map locates these cities as dots of size proportional to the number of wage earners and draws the boundary of the industrial region by assuming that all cities within 53 miles of one another (this "absolute maximum distance" is that between Detroit and Toledo and between Cleveland and Ashtabula) belong together. There are 353 of them listed. Many local centers of industry occur outside, of course. The author describes the rise of manufacturing in the old world and in this country and provides basis for comparison by a map of Sweden's industrial region and a city list with data.

The treatment goes into the geography of industry, comments for instance on the pessimism current with regard to New England's cotton manufactures, and points out that the South cannot hope in the long run to retain more than a single one of her advantages over New England—that of nearness to the cotton fields—the others being pretty sure to disappear with the progress of southern industry. Easily read tables show that most cities even in New England are increasing their number of wage earners from census to census, only Lowell losing as much as 2000. De Geer points out that even dominant industries rarely occupy as many as half the workers of any city. Studies of the principal industries developed are made. Railways, especially those of the manufacturing region, come in for a most illuminating treatment, with a sketch of their history and past and future groupings. Attention is paid to the influence of past waterways as well as the roads of the region, and De Geer shows intimacy with the books on the subject, though his treatment is original and novel.

The paper is in English and exceedingly smooth and flowing English. It appears to the reviewer highly geographic in that it attempts to set before us the totality of the environment in which men have wrought here instead of limited aspects of it.

Mark Jefferson

A Study in Agricultural Geography

Hertha Crohn. **Der Mais in der Weltwirtschaft.** 64 pp.; maps, diagrs. *Veröffentl. Inst. für Meereskunde, V. Hist.-volkswirtsch. Reihe, No. 5*, August, 1926.

Dr. Crohn has added a useful, if brief, monograph to the literature of agricultural geography. This is a survey of the geography of maize (corn) production, trade and utilization, and it is good geography. Throughout there is a careful emphasis on the interrelationship between significant elements of the natural environment and the location of margins of the several maize-producing regions, the character of the grain, and the methods of production.

Most of the facts reviewed in this study of maize are known to American geographers, particularly to those well acquainted with the corn belt. The author introduces the crop through the region of its origin, sets up climatic and soil optima for its cultivation in extra-tropical regions, and discusses its comparative economic values. The next step in the presentation is a word picture of the world regions of corn production. This is supplemented by a small-scale but carefully prepared dot map of the world distribution of corn-producing areas (Mercator's projection).

The major part of the publication consists of a series of sections, each one dealing with the details of the geography and economics of maize production, consumption, and export in one of the important maize regions. These sections are organized on the following plan: (1) climatic conditions responsible for the limits of the maize-growing region, (2) topographic and soil conditions characteristic of the region, (3) economic conditions and agricultural practices associated with the crop, and (4) the rôle of maize in the food economy and in the foreign trade of the region.

The paper as a whole displays a broad knowledge of the literature of regional agronomy. Certain statements indicate lack of familiarity with local conditions. For example it is indicated (p. 12) that in the United States maize covers about 40 per cent of the cultivated land; and again (p. 14), after comments on the favorable character of the convectional showers with maximum precipitation in June, it is stated that the ensuing warm dry period of the "Indian summer" permits a proper ripening of the maize ears. On the contrary, other statements are most illuminating, notably the frequent reference to the significance of corn culture and corn utilization among the hill and mountain farmers of various regions, such as northern Italy and western Rumania.

V. C. FINCH

THE EARTHQUAKE PROBLEM IN SOUTHERN CALIFORNIA

R. T. HILL. **Southern California Geology and Los Angeles Earthquakes, With an Introduction to the Physical Geography of the Region.** xvi and 232 pp.; maps, ills. Southern California Academy of Sciences, Los Angeles, 1928. $5.00. 8 x 5½ inches.

The predictions made several years ago by Bailey Willis, professor of geology emeritus at Stanford University, widely experienced in studies of earthquakes, to the effect that a severe shock is likely to occur in southern California in from three to ten years, are now contradicted in a book by R. T. Hill, widely known for his excellent geological work, especially in Texas. Hill's argumentation is partly inductive, partly deductive. He announces inductively: "Experiences of the past show that no moderately well-constructed buildings has [*sic*] ever been destroyed by earthquakes in Southern California." After 100 pages on the numerous rifts of the region, to which its leading physiographic features are in great measure due, he concludes deductively that the rift movements were largely responses to the depression of the ice-covered part of North America during the Glacial period and that, as we are now in an interglacial epoch, further rift movements of a serious nature are unlikely.

Hill's book will probably be quoted as convincing by realtors who have building lots to sell around Los Angeles; for it has the style of a legal brief, prepared to defend the interests of a client rather than that of a scientific monograpn prepared to set forth impartially all the pros and cons of a highly theoretical and very debatable problem. For example, it is told that "the authorities of the University of California at Los Angeles, by permitting the new buildings . . . to be built almost astride of this line [an allegedly dangerous fault line a few miles west of Los Angeles center] have shown their lack of fear of harm from it." But it is not told that the same authorities permitted the construction of a great stadium at Berkeley a few years

ago and are now permitting the erection of a $300,000 dormitory, the first directly astride, the second close alongside of the Hayward rift or fault line, on which very considerable displacements have taken place in the geologically recent past and on which an earthquake occurred in 1868, similar in violence to that of San Francisco on the San Andreas rift in 1906. It would therefore seem that the lack of fear of harm on the part of the university authorities is not closely related to the lack of stability on the part of the earth's crust.

When the book was first placed on sale it had a red-paper cover on which the purchaser was most erroneously informed, directly over the imprint, "Published by the Southern California Academy of Sciences": "This book completely refutes the predictions of Professor Bailey Willis that Los Angeles is about to be destroyed by earthquakes. It proves that this area is not only free from a probability of severe seismic disturbances but has the least to fear from 'Acts of God' of any [*sic*] city under the American flag." So glaringly false are both these sentences that they have been suppressed and replaced by a milder statement on a later cover; but on both covers we read in a following paragraph: "Here are [*sic*] first given . . . an explanation of the natural causes of our beautiful scenery and charming climate."

A list of errata closes with a note: "In justice to the author it is proper to state that this book was printed without awaiting his final corrections upon the last galley proofs and page proofs." One who knows Hill's other publications must wonder how far his failure to see the final page proof is responsible for the actual form of this book; and one who is familiar with publications of academies of science in general must wonder what sort of an editor or proof reader was employed for Hill's book by the Southern California Academy.

Not enough is yet known of earthquakes in general or of Southern California earthquakes in particular to warrant either predictions of their occurrence or assurances of their non-occurrence; but enough is already known to make safe building construction a wise public policy.

W. M. DAVIS

FIRST GEOLOGICAL REPORT OF THE CENTRAL ASIAN EXPEDITION

C. P. BERKEY AND F. K. MORRIS. **Geology of Mongolia: A Reconnaissance Report Based on the Investigations of the Years 1922–1923.** xxxi and 475 pp.; maps, diagrs., ills., bibliogr., index. (Natural History of Central Asia, Vol. 2.) American Museum of Natural History, 1927. $10.00. 11 x 9 inches.

With this substantial volume the American Museum of Natural History has commenced publication of the scientific results of the Central Asian Expedition. It is mainly occupied with the geological observations along 5000 miles of route traversed in 1922 and 1923 and in the special localities chosen for detailed study. An introduction gives the historical setting of the problem and defines the Gobi region, the theater of the expedition's activities. Reference should be made to the two maps showing respectively the routes of Russian and of non-Russian geologists in Central Asia and to the extensive bibliography. On the north the boundary of the Gobi region follows the Arctic watershed along the fault block range of the Tannu-Ola and the domed masses of the Khangai and thence along the Transbaikal block mountains; the eastern boundary is the Great Khingan; southern and western boundaries are less easily defined, but on the south the Gobi region is considered to include the southern Ordos and on the west the Dzungarian and Lop Nor basins. Thus is enclosed a basin 600 miles by 1000 miles, a vast shallow depression, an alternating succession of broad nearly level plains separated by more rugged areas of the uplifted and dissected hard rock floor (the area was briefly described by Mr. Morris in "Notes on the Mapping Program of the Third Asiatic Expedition in Mongolia," *Geogr. Rev.*, Vol. 14, 1924, pp. 287–292).

The routine account of the geological record is illustrated with informative sketches and diagrams and enlivened with observations on the character of the country and its inhabitants, as for example, the grassland belts of the northern and southern borders. Of the former, at Sain Noin, it is observed that "the valley bottoms are well grassed, flocks and herds are numerous, and more people live in them than we had seen hitherto in any part of the journey" (p. 125). On pages 183–184 is a brief but arresting description of the southern belt now being colonized by Chinese farmers, and the many excellent photographs include one of the grainfields of the colonists (facing p. 48). Concluding sections summarize the structural elements of the old rock floor and the fossiliferous sediments and discuss the surface features and their origin. Of special geographical interest are the observations on climatic change. This area, with its peculiarly delicate climatic balance as regards animal and human life, is of critical importance. From evidences of old river courses and misfit streams, ancient lake beaches and terraced dissected alluvial fans, the outpost forests of the Arctic divide, and the like, it is concluded that "fluctuations have been many and of very unequal intensity and duration." As yet it has not been possible to correlate the fluctuations or assign dates to them, but it is stated that "observations made in 1925 throw a flood of light on the problem of climate in Pleistocene and Recent times." For this and for amplification of other matters dealt with in this volume, which necessarily is of a preliminary nature, further publications of the Expedition will be awaited with the greatest interest.

The Facts About the Earth's Atmosphere

Sir Napier Shaw. **Manual of Meteorology, Vol. II: Comparative Meteorology.** xxxix and 445 pp.; maps, diagrs., index. The University Press, Cambridge, 1928. 36s. 10½ x 7½ inches.

This is the third of a series of four volumes which the former Director of the Meteorological Office set as a task for himself when he laid down his official duties. In this case, certainly the last shall be first, for Volume IV, dealing with the relation of the wind to the distribution of pressure, appeared in 1919 (see review in *Geogr. Rev.*, Vol. 10, 1920, pp. 55–56) and Volume I, "Meteorology in History" in 1926 (see review in *Geogr. Rev.*, Vol. 17, 1927, pp. 687–689). Volume III is yet to come.

No one has done more to develop our knowledge of air motion, air stratification, and what we may call the dynamics of the atmosphere, than Sir Napier Shaw. By training a physicist, with a long experience as teacher and even longer in prominent official capacities, he has had opportunities which can come to but few men; and always he has made wise use of his privileges.

What first strikes the reader is the solid character of the book and the almost lavish use of maps. After a first chapter, giving the energy in kilowatt hours for both northern and southern hemispheres received by direct radiation, with a solar constant of 135 kilowatts per square decameter, we meet the first of the maps in Chapter II, which deals with land, water, and ice; also orographic features and other geophysical agencies. It is acknowledged that the type of map used (circumpolar) has its limitations and shows distortion in equatorial regions, and so special maps (Mercator projection) are employed from 30° N. to 30° S. A mere list of the maps and graphs found in this chapter tells the story of accumulated records in many directions better than if described in several pages of text: these are snow lines and highest mountains, sea ice and icebergs, ice limits, earthquakes, magnetic variation, auroras, and thunderstorm frequency.

Chapter III deals with the composition of the atmosphere—a rather familiar tale.

Chapter IV is a book in itself, dealing with temperature. The list of references requires four closely printed pages. There are 37 maps showing the distribution of temperature for each month at sea level, also mean daily and mean seasonal ranges.

Upper air data are given quite fully, and near the end appear certain departures from the usual Cartesian ordinates of temperature and height in favor of what he calls potential temperature, which is temperature corrected for difference of pressure. In other words, the reasoning is now on a thermodynamic basis. Shaw himself is responsible for introducing the conception of the entropy of a mass of air, which he finds to be proportional to the logarithm of the potential temperature. This enables him to construct new diagrams—in fact improved indicator diagrams; and we have, for example, in Figure 63, the "Variation of Realised Entropy" in a section of the upper air from the Arctic to the Antarctic. The entropy increases but slowly with height in the troposphere but rapidly in the stratosphere. All of which throws light upon the stability of the atmosphere. If the adiabatic runs forward above the graph, saturated air in that position would be unstable, or, as Shaw prefers, "unsistible"; while, if the adiabatic passes to the right of the point where it cuts the graph, even saturated air would be sistible and stable. This is tough chewing for the layman but rich meat for the engineer. We must regard Shaw as doing for air engineering pretty much what Rankine did with his tables for steam engineering.

Chapter V has 83 pages devoted to water vapor. Fog, cloud, and rainfall maps are given *in extenso*. Chapter VI deals with pressure and wind, and Chapter VII with the general circulation and the new concepts of resilience or plasticity. Here too may be found long records of weather, those in our own country being the New Bedford (Rodman) observations from 1814, Baltimore rainfall from 1817, Boston rainfall from 1818 continuous (and interpolated from 1750), and Philadelphia from 1820.

After a voluminous discussion of correlation coefficients, the author remarks that the general impression he derives from it all is bewildering. And in this view most of us will agree. He also says that the relation to solar changes through sun-spot variations is similarly unimpressive. So it would seem that a vast amount of effort has been expended with practically no result so far as ability to utilize these values in forecasting is concerned—which at present is the great desideratum.

Chapter VIII treats of cyclones and anticyclones. Chapter IX is largely on forecasting and some new views of cyclones and anticyclones; and the final chapter sets forth a series of forty-five articles expressing conditions between 4 and 8 kilometers (400 and 800 geodekameters in the new parlance) and their relations with the air strata above and below.

ALEXANDER MCADIE

RAINFALL ATLAS OF THE BRITISH ISLES

Rainfall Atlas of the British Isles. 12 pp.; maps. Royal Meteorol. Soc., London, 1926. 15s. 12½ x 10 inches.

The "Rainfall Atlas of the British Isles" is a very welcome publication. In convenient and compact form, by means of many clear and effective colored charts, it gives a complete and vivid presentation of the essential facts. The frontispiece is an orographical map, showing contour lines, principal rivers and towns, and county boundaries. What a help it would be if the rainfall maps of all countries were invariably accompanied by an orographic map!

Three full-page maps, on the scale of 60 miles to an inch, show the mean annual rainfall (1881–1915), the rainfall of a very wet year (1872), and that of a very dry year (1887). A series of fifty-six half-page maps show, for each year from 1868 to 1923, the annual rainfall expressed as a percentage of the average. There are twelve full-page maps showing the mean monthly rainfall, based on the 35-year period 1881–1915. On all these maps the counties are indicated, with abbreviated names. The mean annual map gives isohyets for 20, 25, 30, 40, 50, 60, 80, 100, 150, and 200 inches. On the monthly maps they are drawn for 1.5, 2, 2.5, 3, 3.5, 4, 5, 6, 8, 10, 15, and

20 inches. The English and the metric units are indicated on opposite sides of the scale of tints. The color scheme is well chosen, and the details of rainfall distribution can very easily be seen.

Dr. Hugh Robert Mill, the recognized authority on the rainfall of the British Isles, has most appropriately written the introductory text. He gives a brief historical summary of the work on rainfall in the British Isles, and a description of the individual maps in the Atlas.

On the mean annual map five districts with rainfalls over 40 inches are shown, on or near the west coasts of Ireland, England, and Scotland. In Wales, "the mountain valleys of Snowdon in the north have a rainfall exceeding 100 inches, culminating in Llyn Llydaw, one of the wettest spots in the British Isles, where the average probably exceeds 200 inches." At the head of Borrowdale, in the English Lake district, the rainfall is over 150 inches. In the Scottish Highlands amounts of over 100 inches are noted over considerable areas, with over 150 inches in Glen Quoich. The mountainous districts of western Ireland also have heavy rainfalls, reaching over 80 inches in a few places. The smallest amounts are found in eastern England, on the lee side of the islands, in the rain shadow. The isohyet of 20 inches, the lowest value on the map, is seen in the district around the mouth of the Thames. The increasing interest that is now being taken in the rainfalls of individual days, and of individual storms, would suggest the query why such maps were not included in the present publication. The answer is doubtless to be found in the fact that maps of this sort have been included in the annual volumes of *British Rainfall.*

Meteorologists are under a real debt of gratitude to the Royal Meteorological Society, under whose direction this most excellent Atlas was prepared, and to Dr. Mill, "to whose inspiration and guidance are mainly due the results and methods which are here presented." The cost of publication was defrayed out of the "British Rainfall Organization Fund" of the Society.

R. DEC. WARD

RECENT LITERATURE ON BIRD MIGRATION

ALEXANDER WETMORE. **The Migrations of Birds.** viii and 217 pp.; ills. Harvard University Press, Cambridge, Mass., 1926. $2.50. 8 x 5½ inches.

HORST WACHS. **Die Wanderungen der Vögel.** *Ergebnisse der Biologie,* Vol. 1, 1926, pp. 479–633.

A. LANDSBOROUGH THOMSON. **Problems of Bird-Migration.** xv and 350 pp.; maps, diagrs., bibliogrs., index. H. F. & G. Witherby, London, 1926. 18s. 9 x 6 inches.

WILLIAM ROWAN. **On Photoperiodism, Reproductive Periodicity, and the Annual Migrations of Birds and Certain Fishes,** *Proc. Boston Soc. of Nat. Hist.*, Vol. 38, 1925–1928, pp. 147–189.

Bird migration is a geographic subject partly because of the relative fixity of route and seasonal periodicity in the observed phenomena and still more because it is not improbable that secular climatic change may have had much to do with its origin. The four works here considered treat the subject both in historical aspect and in the light of contemporary observation and experiment. One of them (Thomson's) represents an effort to review the entire literature of the problem and to correlate a really vast quantity of data with the modern record in the fields of physiology, ecology, and earth history.

Wach's contribution furnishes one of the fullest summaries of the successive migration theories advanced in Europe and America, and of the bearing upon these—largely destructive—of the facts learned through the banding of migrant birds, a custom which has been the outstanding ornithological development of the past two

or three decades. The precise information offered by the recovery of banded birds has naturally filled the place of earlier speculation as regards the speed, the calendar dates, and, to a lesser extent, the route of migrants. In other words, the "how" of migration seems in a fair way to be understood; the "why," however, remains almost as much of a mystery as before.

Rowan's short paper directly attacks the all-important matter of the origin and physiological control of the migratory impulse in the individual bird. His alleged factor, photoperiodism, is not a new idea, but he has supported it by experiments which indicate that a lengthening of the artificial day by electric lights, during the season when the solar day is shortening, has a direct and measurable effect upon the development of birds' gonads and a secondary effect upon the impulse to move to a different latitude.

Wetmore's book, while less important than Thomson's, is in a sense the most original of the three major works here discussed in that it is based largely upon the author's own extraordinarily wide field experience. Even his account of the pre-scientific period, and his discussion of the famous but now hackneyed historical examples that every young ornithologist must learn, are refreshing in the manner of telling. The only serious exception taken by the reviewer is Wetmore's out-and-out acceptance of the time-honored "sense of direction," without further elucidation of the term.

Thomson's voluminous book is divided into three parts relating, respectively, to an outline of the features of migration, studies with special reference to marked birds, and a statement and discussion of the main problems of migration. Throughout the work his citation of the pertinent literature is probably more exhaustive than that of any other author.

Many of the more recently learned details of migration such, for example, as the fact that certain species or groups of individual birds regularly "home" their way to winter haunts no less exact and restricted than their particular breeding sites or areas, may prove surprising to most geographers and biologists. Moreover, it is now certain that food, temperature, and all the other perfectly plain reasons for migration have, in point of fact, little or nothing to do with it. It is worth something to know what does *not* make birds migrate.

ROBERT CUSHMAN MURPHY

ESKIMO ARCHEOLOGY

THERKEL MATHIASSEN. **Archaeology of the Central Eskimos: I. Descriptive Part,** vi and 327 pp.; maps, diagrs., ills.; **II. The Thule Culture and Its Position Within the Eskimo Culture,** 208 pp.; map, diagrs., ills. (Report of the Fifth Thule Expedition 1921–24, the Danish Expedition to Arctic North America in charge of Knud Rasmussen, Ph.D., Vol. 4.) Copenhagen, 1927. 11 x 7 inches.

This work auspiciously opens the series of scientific reports that will present the results of Knud Rasmussen's Fifth Thule Expedition to the Arctic. Rasmussen himself has already published the general history of his expedition in a fascinating volume, "Across Arctic America" (reviewed by W. Thalbitzer in the *Geogr. Rev.*, Vol. 17, 1927, pp. 341–342). Mathiassen now follows with the first of the two archeological reports. No one who has experienced the peculiar difficulties of archeological work in the frozen soil of the Arctic will fail to admire the extraordinary enthusiasm of the author and his colleagues in investigating so many sites, in places so widely separated as Repulse Bay and Southampton Island in Hudson Bay, Ponds Inlet and Button Point at the north end of Baffin Island, and King William Island near the magnetic pole; and his admiration will increase as he remarks the meticulous care with which they excavated each ruin. The same industry and care are visible on every page of

this report, which opens up a new vista into Eskimo prehistory. Mathiassen presents his material logically and with great fullness, separates clearly the theoretical conclusions from the ascertained facts, and illustrates all the more important specimens. The reader would prefer legends against each plate to save much time in searching for descriptions of the specimens through the text; but this is a small defect in a well-balanced and carefully presented account that runs into several hundred pages.

The work is divided into two parts. The first, which describes the ruins and the specimens found in them, calls for little comment. The presence of a few specimens of nephrite (jade) on the west coast of Hudson Bay and on Baffin Island may conceivably indicate an early trade connection with northern Alaska, since geologists have not recorded this mineral east of the Rocky Mountains; more probably, however, it exists somewhere on Baffin Island, which is still largely unexplored. The reviewer's theory (*Geogr. Rev.*, Vol. 13, 1923, pp. 547 f.) that copper was unknown to the Eskimos of the ancient Thule culture but was acquired first by the Eskimos who migrated later into the region of Coronation Gulf is disproved not only by the presence of some copper objects in the ruins excavated by the expedition but also by the recent discovery of a harpoon head with copper blade in an old stone house of the Thule period within the Coronation Gulf area itself. Copper seems to have been rare at this period, however; possibly because the Eskimos had not yet discovered the principal outcrop of the metal near the Coppermine River.

After describing the archeological remains on Southampton Island Mathiassen gives an interesting account of its former inhabitants, the Sadlermiut, gleaned from some mainland Eskimos who had come into contact with the last survivors of the tribe; and he confirms Munn's statement (*Geogr. Journ.*, Vol. 54, 1919, p. 54) that an infectious disease introduced by a trading vessel, not starvation, was responsible for their extinction.

In Part II Mathiassen analyzes his material and discusses the distribution of the specimens throughout Eskimo territory. His classification of harpoon heads, although not quite complete since it scarcely covers all the multifarious types known in the western Arctic, is far in advance of those proposed by earlier writers; and his clear definition of the elements contained in the ancient Thule culture, as contrasted with the modern culture in the eastern Arctic, provides a new and safe groundwork for all future researches into Eskimo prehistory. To the elements attributed to the Thule culture one feels inclined to add the sealing net of baleen or rawhide; for, although he found no trace of it in Hudson Bay, it seems to have been known in Greenland in pre-European times, and a mesh gauge for its manufacture has been discovered in an ancient ruin at Wales, Alaska. The fish net, on the other hand, is now known to have reached Bering Strait at the same time as iron, about 1700, and to have spread thence to the Mackenzie River delta; its absence from older remains in Alaska strongly favors the probability of its introduction by Europeans into the Hudson Bay region—unless, indeed, the eastern natives acquired it earlier from the Indians of the interior.

Incidentally, it may be observed that not all the ruins on Barter Island, in northern Alaska, belonged to the stone age, as Mathiassen states (Part II, p. 58). In 1914 the reviewer carefully excavated fifteen house sites on the west end of the island and nearly sixty house sites, tent sites, and graves on the east end; two houses and several of the graves contained iron; and none of the ruins were older, apparently, than 300 years, for all the sealing harpoon heads had closed sockets, like those in use during the nineteenth century, whereas in Bering Strait the older, open-socketed types were still common at the introduction of iron. Mathiassen's theory, however, that more ancient ruins in the western Arctic might show a greater resemblance to the Thule remains of the Hudson Bay region has been confirmed by recent researches in Bering Strait; and it is difficult to refute his argument that the Thule culture as a whole originated in the west.

Concerning the earliest home of the Eskimo Mathiassen cautiously expresses no opinion, rightly believing that the question cannot be settled without further archeological investigations in Alaska. Investigations are necessary, also, in the Hudson Strait region and in Labrador, to unravel the mysterious Cape Dorset culture, which, even as represented in the remains that he excavated at Button Point, stands in striking contrast to the Thule and later cultures at Ponds Inlet in the same region. There seems to have been a mutual borrowing of culture elements between the Beothuk and the people of the Cape Dorset culture; and, as the former were isolated in Newfoundland from 1600 A. D. onward, this borrowing must have occurred at least a century and probably several centuries before that date. If, then, the Cape Dorset culture is but a locally stamped phase of the Thule, as Mathiassen thinks, it must be quite an ancient variation to react on the Beothuk, to spread from Labrador to Ellesmere Island, and to leave its marks even in King William Land and Greenland. May it not be possible, in view of its limitation to the eastern Arctic, its wide diffusion in that area, its marked differences from the Thule stage of Eskimo culture, and its links with the Beothuk, that it sprang from an earlier Eskimo source still unknown and that it failed to survive in conflict with the more advanced cultures of Thule and post-Thule times? Such a theory, of course, still further complicates the problem of Eskimo prehistory; but, after all, that prehistory is to be measured not by centuries only but by millenniums.

D. JENNESS

THE ESKIMOS OF CORONATION GULF

DIAMOND JENNESS. **The People of the Twilight.** xii and 247 pp.; maps, ills. The Macmillan Co., New York, 1928. $3.00. 9 x 6 inches.

A "charming narrative," says Dr. Nansen in his preface; and the expression is just. This Odyssey of the wandering life of the primitive Eskimos of Coronation Gulf is told with deep sympathy and great artistry. As a member of the Canadian Arctic Expedition Mr. Jenness spent two years among them and, as an adopted son of the couple Ikpuck and Icehouse, lived "from autumn to autumn" as one of themselves. His scientific reports have been unusually interesting, but the present work makes still more vivid the picture of a people close bound to its environment in all its thoughts and deeds.

"In winter, when the land lay bare and silent beneath the snow, when the caribou had migrated south, when the twilight hours were brief and the nights long, the natives had banded together into tribes, and tribe combined with tribe to wrest a precarious livelihood from the frozen sea by united effort. Food had been common to all, and their snow-houses had adjoined each other so closely that the families seemed absorbed in the group. With the returning sun and lengthening days nature had recalled its life; the seals had appeared on top of the ice, the caribou had come northward again, and the tribes of Eskimos had broken up into little bands. For a time they had lingered on the ice to hunt more seals; then, turning landward, they had pursued the caribou over the snow-covered hills and plains. Now the snow was vanishing, the caribou had scattered, and fish alone provided a sure livelihood until midsummer. So my party, like many another throughout the country, was dividing into its constituent households, each of which now toiled for itself alone. The tribe no longer existed; society had dissolved into its first element, the family."

Such rigorous control implies marginal existence. There is always the threat of starvation, when the lights fail to "burn brightly again in every home" and there is no "dining sumptuously on dried trout and frozen salmon." A balance so precarious under nature must be profoundly disturbed by the entry of an alien civilization, and that entry has commenced for the "Twilight Land": what will its outcome be? On this query Mr. Jenness concludes his moving story.

The Great Nomad Conqueror

Harold Lamb. **Genghis Khan: The Emperor of All Men.** viii and 270 pp.; maps, ills., bibliogr., index. Robert M. McBride & Co., New York, 1927. $3.50. 9 x 6 inches.

Theodore Roosevelt, in his Foreword to Jeremiah Curtin's "The Mongols, A History," protests vigorously and justly against the prevailing ignorance regarding what he calls "the most stupendous fact of the [thirteenth] century—the rise of Genghis Khan and the spread of the Mongol power from the Yellow Sea to the Adriatic and the Persian Gulf."

Asia has always been fertile in men of the highest genius. Among these have been Ch'in Shih-huang, the first founder of the Chinese Empire, in the third century before Christ; Attila, the "Scourge of God," whose forbears if not he himself were Asiatics; T'ang T'ai-tsung, the second founder of the Chinese Empire, in the seventh century of our era, beyond question the most powerful ruler of his day; and Tamerlane, the mighty "Earth Shaker," to name but a few of the greatest. But greater than any, both in the difficulties he overcame and in the results he achieved in his own lifetime, was the superman whose life story forms the theme of Mr. Lamb's book. As the author says,

"And here we are face to face with the mystery that surrounds Genghis Khan. A nomad, a hunter and herder of beasts, outgeneraled the powers of three empires; a barbarian who had never seen a city and did not know the use of writing drew up a code for fifty peoples. . . . Of necessity we must turn to Alexander of Macedon . . . . .to find a conquering genius the equal of Genghis Khan. . . Both died in the full tide of victory, and their names survive in the legends of Asia to-day."

Mr. Lamb's book is symptomatic of the desire to know more about Asia which has been growing steadily during recent years. That the author, perhaps best known hitherto as a purveyor of excellent historical tales with an Asiatic setting, is blessed with a happy knack of description, the following will show:

"Life did not matter very much in the Gobi. Lofty plateaus, windswept, lying close to the clouds. Reed bordered lakes, visited by migratory winged creatures on their way to the northern tundras. Huge Lake Baïkul visited by all the demons of the upper air. In the clear nights of mid-winter, the flare of the northern lights rising and falling above the horizon.

"Children of this corner of the northern Gobi were not hardened to suffering; they were born to it. After they were weaned from their mother's milk to mare's milk they were expected to manage for themselves."

Or take the following, in regard to the Mongols' amazing march westward:

"Entering the western ranges beyond the Gate of the Winds, the warriors cut down trees, hewing out massive timbers to be used in bridging the gorges. The ponies dug up moss and dry grass with their hoofs from under the snow. The hunters went afield for game. Forging ahead in the utter cold of high Asia, a quarter million men endured hardships that would have put a modern division into hospital. The Mongols did not mind it particularly. Wrapped up in their sheepskins and leather, they could sleep under drifting snow; at need, the round, heavy *yurts* [hemispherical felt tents] warmed them. When food failed, they opened a vein in a horse, drank a small quantity of blood and closed the vein."

Mr. Lamb's book, of interest from many points of view, is not least so from that of human geography. In the course of his story, he gives us vivid pictures of that type of culture which from before the dawn of history has characterized the steppe regions of the Old World. That culture was in many ways a direct response to the demands of an almost unimaginably severe environment, and it seems to have taken on definite and final form somewhere around the close of the second millennium

before the Christian era, with the development of the "horse-archer" type of warrior. It was not long thereafter till the civilized portions of the Old World began to be tormented by the onslaughts of the fierce riders of Central Asia.

But the recurrent outbursts of raiding and turmoil and bloodshed meant among other things the trampling down of the national barriers that have always tended to erect themselves in the way of free travel across the breadth of Asia. This has happened time and again. The first well authenticated journey under such circumstances appears to have been that of the Chinese explorer and diplomatic agent, Chang Ch'ien, in the second century before Christ; although we might perhaps be able to point to an earlier instance in the travels of Aristeas of Proconnesus (seventh century before Christ?), had we but his lost poem, the *Arimaspeia*. The transcontinental journeys of John of Plano Carpini, of William of Rubruk, of the Polos, of John of Monte Corvino, of Ibn Batuta, and many lesser lights of the period could never have taken place but for the conquests of Genghis Khan.

The net result of such journeys was to reawaken Occidental interest in the lands of silk and spice, just at the time when the Ottoman Turks, themselves set in motion by the impact of the Mongol incursion, were about to erect anew the barriers in the way of free intercourse between East and West. As is well known, Columbus sought not a New World but an alternative route to the realm of the Grand Khan. This is still another point of view from which a study of the life and acts of the great Mongol leader and the consequences which flowed from them is indispensable to a right understanding of historical geography.

Mr. Lamb's illustrations are well chosen and really illustrative, while his book has a useful bibliography and a first-class index. It is a compact, convenient, and very readable account of the life of one of the world's greatest geniuses.

C. W. Bishop

Memorial to an Eminent Russian Geographer

A. A. Dostoĭevsky, edit. **Peter Petrovitsh Semenov-Tian-Shansky,** sa vie et son oeuvre. 265 pp.; ills., bibliogr. Société Russe de Géographie, Leningrad, 928. 11 x 7½ inches. [In Russian.]

In this special publication of the Russian Geographical Society a number of Russian scientists, mostly former collaborators, here give an appreciation of the eminent and versatile scientist, statesman, and humanitarian, Peter Semenov-Tian-Shansky, who died February 26, 1914, at the age of 87. The scope, scale, and fundamentality of his work, together with his efficiency and the fine human qualities of his personality, are dominant notes of the volume. In 1849 the young Semenov was elected a member of the recently founded Russian Geographical Society and appointed its librarian, his career as a geographer thus being determined. In various capacities he was associated with the Society to the end of his life, from 1860 to 1873 acting as president of the section of physical geography and from this date as vice-president of the Society. His first geographical work was the description of New California, New Mexico, and Oregon in physical, political, and ethnographical relations, published in 1851. Among his capital works are his translation of Karl Ritter's "Asia," in nine volumes with extensive supplements bringing it up to date; a geographical statistical dictionary of the Russian Empire, published under his direction, the greater number of the important articles being written by him; "The History of the Fiftieth Anniversary of Activity of the Russian Geographical Society 1845–1895," in three volumes, with the collaboration of A. A. Dostoĭevsky—a work, as Schokalsky says, that "is the real monument to the activity of the Society and the geographical study of Russia." A long series of the author's geographical works have been published in the periodicals of that Society and in special publications elsewhere.

As a geographer and explorer, Semenov-Tian-Shansky obtained his name from his expedition to Tian Shan in 1856–1857, the first successful expedition to this difficult region. Its success was due to thorough preparation and organization and to a scientific foresight possessed by him also in other domains. While directing the Russian Geographical Society he at the same time inspired other extensive geographical explorations of northeastern and central Asia—those of Prjevalski, Potanin, Grum Grzhimailo, Mushketov, Koslov, Obruchev, Bogdanovich and others.

Besides attaining scientific distinction he was an eminent statesman who gained a name in the public life of Russia as one of the workers for the freedom of Russian peasants from serfdom. For many years he organized the collection of Russian official statistics including the first Russian census, of the necessity of which he was conscious and labored to make the government recognize its importance, for more than thirty years.

He was the recipient of many honors. In 1906 the addition of Tian Shan to his name of Semenov was granted, not only to him but to his descendants. A number of geographical features have been named for him, mostly in Central Asia but also in Caucasus, Spitsbergen, Kara Sea, as well as Semenov Mountain in Alaska on the right shore of the Yukon. About a hundred families, genera and species of mammals, birds, fish, insects, plants, fossils bear the name of Semenov—for he was botanist, entomologist and geologist as well as geographer. The Russian Geographical Society established a medal bearing his name; he himself received several medals and was on the honorable list of many scientific institutions at home and abroad, among them the American Geographical Society of which he was elected a corresponding member in 1896.

The Line of Demarcation, 1493

Paul Gottschalk. **The Earliest Diplomatic Documents on America: The Papal Bulls of 1493 and the Treaty of Tordesillas Reproduced and Translated with Historical Introduction and Explanatory Notes.** 91 pp.; plates, bibliogr. Paul Gottschalk, Berlin, 1927. $66.50. 12 x 15¾ inches.

Paul Gottschalk, Berlin bookseller and publisher, has done a useful piece of work. The bulls of Alexander VI, which divided the earth's surface between Spain and Portugal, and the Treaty of Tordesillas, which established the famous demarcation line as running from pole to pole and passing through a point 370 leagues east of the Cape Verde Islands, are, as Gottschalk says, "among the most important diplomatic documents ever issued." To a very large extent they are "responsible for the fact that in certain parts of America Spanish is the spoken language while in others it is Portuguese." Besides their geographical interest they occupy an important place in the development of international law.

In the sumptuously printed and richly bound volume before us the photographic reproductions of the original documents, the transliterations, and the bibliography will be of unquestioned value to scholars. It could be wished, however, that Mr. Gottschalk's English were clearer, not only in the translations, where obscurity may be excused on the ground of the obscurity of the original, but in the explantory text and discussions of controversial matters. A work of this importance and costliness ought to have been carefully revised and parts of it even rewritten by someone thoroughly competent in the art of English expression. Furthermore, we fail to see the point of the reprints from Dr. E. L. Stevenson's "Maps Illustrating Early Discovery and Exploration in America, 1502–1530"—at least we find it difficult to understand why these reprints are given in the form that Gottschalk has adopted. The three maps are cut up into no less than fifty-one separate sections, some of which show nothing but ocean and margin. As no reduced facsimiles of the three original sheets are supplied, it is impossible to gain an idea of the maps as a whole.

French Geographical Books of the Sixteenth Century

Geoffroy Atkinson. **La littérature géographique française de la Renaissance: Répertoire bibliographique.** 565 pp.; ills., index. August Picard, Paris, 1927.

Before the close of the fifteenth century the average Occidental's idea of the world beyond the bounds of Europe was vague and blurry—like the image seen through an unfocused field glass. Exploration into remote regions alone did not suffice to bring clarity to his view. The Norsemen reached America in the tenth century, Marco Polo wandered through the greater part of Asia in the thirteenth, and missionaries penetrated China, India, and Abyssinia in the fourteenth and fifteenth; but what they observed did not dispel the mists of general geographic ignorance and confusion. It was the introduction of the printing press which brought the outside world into focus for European eyes and enabled the ordinary reader to see clearly lands and peoples beyond his near horizon.

That printed books of travel dealing with exotic regions became very popular in France in the sixteenth century is shown by the admirable publication under review. Careful bibliographic descriptions are here given of 524 works, all of which were published in French between 1480 and 1610 and each of which deals for the major part with non-European countries. Professor Atkinson has based his study on the direct examination of the books themselves in the libraries of France and gives useful indications of where copies may be found. His volume is carefully worked out and thoroughly indexed. An interesting feature is a series of 300 reduced photographic reproductions of title pages. The book should prove an indispensable tool for students of the spread of geographical knowledge during the great Age of Discovery.

A New York State Park Handbook

A. K. Lobeck. **A Popular Guide to the Geology and Physiography of Allegany State Park.** 288 pp.; maps, diagrs., ills., bibliogr., index. (New York State Museum Handbook 1.) Albany, 1927.

Allegany State Park is an area of about 100 square miles lying in western New York, within the great bend of the Allegheny River. Together with the Allegheny National Forest of Pennsylvania, which it borders on the north, it comprises a region well suited to the study and preservation of natural life. It is largely a forest wilderness forming part of the northeastern hardwood belt, though there are some farms in the main valleys. Situated in the submaturely dissected Allegheny Plateau, it is physiographically and geologically a comparatively simple area. Professor Lobeck's method of dealing with his material is one which hitherto has been somewhat rarely used in this country. In addition to giving a description of the park he has undertaken to present to the reader the underlying principles of physical geography. To do this he has divided his work into chapters dealing with the general geology of the region, the rivers and valleys of the park, and the ice age in the park; and to each of these chapters he has added a supplementary one dealing with the broader aspect of the topic. Among his maps is one (p. 120) showing the terminal moraine in Pennsylvania, compiled by W. C. Alden and giving information additional to the Pennsylvania Geological Survey map published in 1881, and also a physiographic diagram of the same nature as the author's earlier ones of Europe and the United States. "The Flora of the Allegany State Park Region," by H. D. House and W. P. Alexander, and "The Amphibians and Reptiles of Allegany State Park," by S. C. Bishop, comprise respectively the second and third handbooks of the New York State Museum.